Appendix

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Appendix

California Environmental Protection Agency

State Water Resources Control Board Water Quality Website

The California Environmental Protection Agency SWRCB Water Quality website www.swrcb.ca.gov/swamp/qapp.html outlines the sections and appendices of a Surface Water Ambient Monitoring Program (SWAMP) QAPP. The following table of contents is from the website:

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A helpful reference for QAPP development and preparation is DWR's "Guidelines for preparing a QAPP."

Table 1: Salt Tolerance of Herbaceous Crops[1]

Crop		Salt tolerance parameters				References
Common name	Botanical name[‡]	Tolerance based on:	Threshold[¶] (Ec_e)	Slope dS/m	Rating[#] % per dS/m	
Fiber, grain, and special crops						
Artichoke, Jerusalem	*Helianthus tuberosus* L.	Tuber yield	0.4	9.6	MS	Newton et al., 1991
Barley[††]	*Hordeum vulgare* L.	Grain yield	8.0	5.0	T	Ayers et al., 1952 Hassan et al., 1970a
Canola or rapeseed	*Brassica campestris* L. [syn. B. *rapa L.*]	Seed yield	9.7	14	T	Francois, 1994a
Canola or rapeseed	*B. napus* L.	Seed yield	11.0	13	T	Francois, 1994a
Chick pea	*Cicer arietinum* L.	Seed yield	—	—	MS	Manchanda & Sharma, 1989; Ram et al., 1989
Corn[§§]	*Zea mays* L.	Ear FW	1.7	12	MS	Bernstein & Ayers, 1949b (p. 41-42); Kaddah & Ghowail, 1964
Cotton	*Gossypium hirsutum* L.	Seed cotton yield	7.7	5.2	T	Bernstein, 1955 (p. 37-41), 1956 (p. 33-34); Berntein & Ford, 1959a (p. 34-35).
Crambe	*Crambe abyssinica*	Seed yield	2.0	6.5	MS	Francois & Kleiman, 1990 Hochst. Ex R. E. Fries
Flax	*Linium usitatissimum* L.	Seed yield	1.7	12	MS	Hayward & Spurr, 1944
Guar	*Cyamopsis tetragonoloba* (L.) Taub.	Seed yield	8.8	17	T	Francois et al., 1990
Kenaf	*Hibiscus cannabinus* L.	Stem DW	8.1	11.6	T	Francois et al., 1992
Millet, channel	*Echinochloa turnerana*	Grain yield	—	—	T	Shannon et al., 1981 (Domin) J.M. Black
Oat	*Avena sativa* L.	Grain yield	—	—	T	Mishra & Shitole, 1986; USSL[‡‡]
Peanut	*Arachis hypogaea* L.	Seed yield	3.2	29	MS	Shalhevet et al., 1969
Rice, paddy	*Oryza sativa* L.	Grain yield	3.0[¶¶]	12[¶¶]	S	Ehrler, 1960; Narale et al., 1969; Pearson, 1959; Venkateswarlu et al., 1972
Roselle	*Hibiscus sabdariffa* L.	Stem DW	—	—	MT	El-Saidi & Hawash, 1971
Rye	*Secale cereale* L.	Grain yield	11.4	10.8	T	Francois et al., 1989
Safflower	*Carthamus tinctorius* L.	Seed yield	—	—	MT	Francois & Bernstein, 1964b
Sesame[##]	*Sesamum indicum* L.	Pod DW	—	—	S	Yousif et al., 1972
Sorghum	*Sorghum bicolor* (L.)	Grain yield	6.8	16	MT	Francois et al., 1984 , Moench
Soybean	*Glycine max* (L.) Merrill	Seed yield	5.0	20	MT	Abel & McKenzie, 1964; Bernstein et al., 1955b (p. 35-36); Bernstein & Ogata, 1966
Sugarbeet[†††]	*Beta vulgaris* L.	Storage root	7.0	5.9	T	Bower et al., 1954
Sugarcane	*Saccharum officinarum* L.	Shoot DW	1.7	5.9	MS	Bernstein et al., 1966; Dev & Bajwa, 1972; Syed & El-Swaify, 1972
Sunflower	*Helianthus annuus* L.	Seed yield	4.8	5.0	MT	Cheng, 1983; Francois, 1996
Triticale	*X Triticosecale* Wittmack	Grain yield	6.1	2.5	T	Francois et al., 1988
Wheat	*Triticum aestivum* L.	Grain yield	6.0	7.1	MT	Asana & Kale, 1965; Ayers et al., 1952; Hayward & Uhvits, 1944 (p. 41-43)
Wheat (semidwarf)[‡‡‡]	*T. Aestivum* L	Grain yield	8.6	3.0	T	Francois et al., 1986
Wheat, Durum	*T. Turgidum* L. var. *durum* Desf.	Grain yield	5.9	3.8	T	Francois et al., 1986

Table 1: Salt Tolerance of Herbaceous Crops[1] (continued)

Crop		Salt tolerance parameters				References
Common name	Botanical name[‡]	Tolerance based on:	Threshold[¶] (Ec_e)	Slope dS/m	Rating[#] % per dS/m	
Grasses and forage crops						
Alfalfa	*Medicago sativa* L.	Shoot DW	2.0	7.3	MS	Bernstein & Francois, 1973a; Bernstein & Ogata, 1966; Bower et al., 1969; Brown & Hayward, 1956; Gauch & Magistad, 1943; Hoffman et al., 1975
Alkaligrass, Nuttall	*Puccinellia airoideS*	Shoot DW	—	—	T*	USSL staff, 1954 (Nutt.) Wats. & Coult.
Alkali sacaton	*Sporobolus airoides* Torr.	Shoot DW	—	—	T*	USSL staff, 1954
Barley (forage) [††]	*Hordeum vulgare* L.	Shoot DW	6.0	7.1	MT	Dregne, 1962; Hassan et al., 1970a
Bentgrass, creeping	*Agrostis stolonifera* L.	Shoot DW	—	—	MS	Younger et al., 1967
Bermudagrass[§§§]	*Cynodon dactylon* L. Pers.	Shoot DW	6.9	6.4	T	Bernstein & Ford, 1959b (p. 39-44); Bernstein & Francois, 1962 (p. 37- 38); Langdale & Thomas, 1971
Bluestem, Angleton	*Dichanthium aristatum* (Poir.) C.E. Hubb. [syn. *Andropogon nodosus* (Willem.) Nash]	Shoot DW	—	—	MS*	Gausman et al., 1954
Broadbean	*Vicia faba* L.	Shoot DW	1.6	9.6	MS	Ayers & Eberhard, 1960
Brome, mountain	*Bromus marginatus* Nees ex Steud.	Shoot DW	—	—	MT*	USSL staff, 1954
Brome, smooth	*B. inermis* Leyss	Shoot DW	—	—	MT	McElgunn & Lawrence, 1973
Buffellgrass	*Pennisetum ciliare* (L.) Link. [syn. *Cenchrus ciliaris*]	Shoot DW	—	—	MS*	Gausman et al., 1954
Burnet	*Poterium sanguisorba* L.	Shoot DW	—	—	MS*	USSL staff, 1954
Canarygrass, reed	*Phalaris arundinacea* L	Shoot DW	—	—	MT	McElgunn & Lawrence 1973
Clover, alsike	*Trifolium hybridium* L.	Shoot DW	1.5	12	MS	Ayers, 1948a
Clover, Berseem	*T. alexandrinum* L.	Shoot DW	1.5	5.7	MS	Asghar et al., 1962; Ayers & Eberhard, 1958 (p. 36-37); Ravikovitch & Porath, 1967; Ravikovitch & Yoles, 1971
Clover, Hubam	*Melilotus alba* Dest. var. *annua* H. S. Coe	Shoot DW	—	—	MT*	USSL staff, 1954
Clover, ladino	*Trifolium repens* L	Shoot DW	1.5	12	MS	Ayers, 1948a; Gauch & Magistad, 1943
Clover, Persian	*T. resupinatum* L	Shoot DW	—	—	MS*	de Forges, 1970
Clover, red	*T. pratense* L.	Shoot DW	1.5	12	MS	Ayers, 1948a; Saini, 1972
Clover, strawberry	*T. fragiferum* L.	Shoot DW	1.5	12	MS	Ayers, 1948a; Bernstein & Ford, 1959b (p. 39-44); Gauch & Magistad, 1943
Clover, sweet	*Melilotus sp.* Mill.	Shoot DW	—	—	MT*	USSL staff, 1954
Clover, white Dutch	*Trifolium repens* L	Shoot DW	—	—	MS*	USSL staff, 1954
Corn (forage) [§§]	*Zea mays* L.	Shoot DW	1.8	7.4	MS	Hassan et al., 1970b; Ravikovitch, 1973; Ravikovitch & Porath, 1967
Cowpea (forage)	*Vigna unguiculata* (L.) Walp.	Shoot DW	2.5	11	MS	West & Francois, 1982
Dallisgrass	*Paspalum dilatatum* Poir.	Shoot DW	—	—	MS*	Russell, 1976
Dhaincha	*Sesbania bispinosa* (Linn.) W.F. Wright [syn.	Shoot DW	—	—	MT	Girdhar, 1987; Karadge

Table 1: Salt Tolerance of Herbaceous Crops[1] (continued)

Crop		Salt tolerance parameters				References
Common name	Botanical name[‡]	Tolerance based on:	Threshold[¶] (Ec_e)	Slope dS/m	Rating[#] % per dS/m	
Grasses and forage crops (con't)						
Fescue, tall	*Festuca elatior* L.	Shoot DW	3.9	5.3	MT	Bower et al., 1970; Brown & Bernstein, 1953 (p. 44-46)
Fescue, meadow	*Festuca pratensis* Huds.	Shoot DW	—	—	MT*	USSL staff, 1954
Foxtail, meadow	*Alopecurus pratensis* L.	Shoot DW	1.5	9.6	MS	Brown and Bernstein, 1953 (p. 44-46)
Glycine	*Neonotonia wightii* [syn. *Glycine wightii* or *javanica*	Shoot DW	—	—	MS	Russell, 1976; Wilson, 1985
Gram, black or Urd bean	*Vigna mungo* (L.) Hepper [syn. *Phaseolus mungo* L.]	Shoot DW	—	—	S	Keating & Fisher, 1985
Grama, blue	*Bouteloua gracilis* (HBK) Lag. Ex Steud.	Shoot DW	—	—	MS*	USSL staff, 1954
Guinea grass	*Panicum maximum* Jacq.	Shoot DW	—	—	MT	Russell, 1976
Hardinggrass	*Phalaris tuberosa* L. var. *stenoptera* (Hack) A.S.	Shoot DW	4.6	7.6	MT	Brown & Bernstein, 1953 (p. 44-46) Hitchc.
Kallargrass	*Leptochloa fusca* (L. Kunth [syn. *Diplachne fusca* Beauv.]	Shoot DW	—	—	T	Sandhu et al., 1981
Lablab bean	*Lablab purpureus* (L.) Sweet [syn. *Dolichos lablab* L.]	Shoot DW	—	—	MS	Russell, 1976
Lovegrass[¶¶¶]	*Eragrostis sp*. N. M. Wolf	Shoot DW	2.0	8.4	MS	Bernstein & Ford, 1959b (p. 39-44)
Milkvetch, Cicer	*Astragalus cicer* L.	Shoot DW	—	—	MS*	USSL staff, 1954
Millet, Foxtail	*Setaria italica* (L.) Beauvois	Dry Matter	—	—	MS	Ravikovitch & Porath, 1967
Oatgrass, tall	*Arrhenatherum elatius* (L.) Beauvois ex J. Presl & K. Presl	Shoot DW	—	—	MS*	USSL staff, 1954
Oat (forage)	*Avena sativa* L.	Straw DW	—	—	T	Mishra & Shitole, 1986; USSL[‡‡]
Orchardgrass	*Dactylis glomerata* L.	Shoot DW	1.5	6.2	MS	Brown & Bernstein, 1953 (p. 44-46); Wadleigh et al., 1951
Panicgrass, blue	*Panicum antidotale* Retz.	Shoot DW	—	—	MS*	Abd El-Rahman et al., 1972; Gausman et al., 1954
Pigeon pea	*Cajanus cajus* (L.) Huth [syn. *C. indicus* (K.) Spreng.]	Shoot DW	—	—	S	Subbaro et al., 1991; Keating & Fisher, 1985
Rape (forage)	*Brassica napus* L.		—	—	MT*	USSL staff, 1954
Rescuegrass	*Bromus unioloides* HBK	Shoot DW	—	—	MT*	USSL staff, 1954
Rhodesgrass	*Chloris Gayana* Kunth.	Shoot DW	—	—	MT	Abd El-Rahman et al., 1972; Gausman et al., 1954
Rye (forage)	*Secale cereale* L.	Shoot DW	7.6	4.9	T	Francois et al., 1989
Ryegrass, Italian	*Lolium multiforum* Lam.	Shoot DW	—	—	MT*	Shimose, 1973
Ryegrass, perennial	*Lolium perenne* L.	Shoot DW	5.6	7.6	MT	Brown & Bernstein, 1953 (p. 44-46)
Ryegrass, Wimmera	*L. Rigidum* Gaud.	—	—	—	MT*	Malcolm & Smith, 1971
Saltgrass, desert	*Distichlis spicta* L. var. *stricta* (Torr.) Bettle	Shoot DW	—	—	T*	USSL staff, 1954
Sesbania	*Sesbania exaltata* (Raf. V.L. Cory	Shoot DW	2.3	7.0	MS	Bernstein, 1956 (p. 33-34)
Sirato	*Macroptilium atropurpureum* (D.C.) Urb.	Shoot DW	—	—	MS	Russell, 1976

Table 1: Salt Tolerance of Herbaceous Crops[1] (continued)

Crop		Salt tolerance parameters				References
Common name	**Botanical name**[‡]	**Tolerance based on:**	**Threshold**[¶] **(Ec_e)**	**Slope dS/m**	**Rating**[#] **% per dS/m**	
Grasses and forage crops (con't)						
Sphaerophysa	*Sphaerophysa salsula* (Pall.) DC	Shoot DW	2.2	7.0	MS	Francois & Bernstein, 1964a (p. 52-53)
Sudangrass	*Sorghum sudanense* (Piper) Stapf	Shoot DW	2.8	4.3	MT	Bower et al., 1970
Timothy	*Phleum pratense* L.	Shoot DW	—	—	MS*	Saini, 1972
Trefoil, big	*Lotus pedunculatus* Cav.	Shoot DW	2.3	19	MS	Ayers, 1948a,b (p. 23-25)
Trefoil, narrowleaf birdsfoot	*L. corniculatus* var *tenuifolium* L.	Shoot DW	5.0	10	MT	Ayers, 1948a, b (p. 23-25)
Trefoil, broadleaf birdsfoot	*L. corniculatus* L. var *arvenis* (Schkuhr) Ser. ex DC	Shoot DW	—	—	MS	Ayers, 1950b (p. 44-45)
Vetch, common	*Vicia angustifolia* L.	Shoot DW	3.0	11	MS	Ravikovitch & Porath, 1967
Wheat (forage)[‡‡‡]	*Triticum aestivum* L.	Shoot DW	4.5	2.6	MT	Francois et al., 1986
Wheat, Durum (forage)	*T. turgidum* L. var. durum Desf.	Shoot DW	2.1	2.5	MT	Francois et al., 1986
Wheatgrass, standard crested	*Agropyron sibiricum*	Shoot DW	3.5	4.0	MT	Bernstein & Ford, 1958 (p. 32-36)
Wheatgrass, fairway crested	*A. cristatum* (L.) Gaertn. (Willd.) Beauvois	Shoot DW	7.5	6.9	T	Bernstein & Ford, 1958 (p. 32-36)
Wheatgrass, intermediate	*A. intermedium* (Host)	Shoot DW	—	—	MT*	Dewey, 1960 Beauvois
Wheatgrass, slender	*A. trachycaulum* (Link) Malte	Shoot DW	—	—	MT	McElgunn & Lawrence, 1973
Wheatgrass, tall	*A. elongatum* (Hort) Beauvois	Shoot DW	7.5	4.2	T	Bernstein & Ford, 1958 (p. 32-36)
Wheatgrass, western	*A. Smithii* Rydb.	Shoot DW	—	—	MT*	USSL staff, 1954
Wildrye, Altai	*Elymus angustus* Trin.	Shoot DW	—	—	T	McElgunn & Lawrence, 1973
Wildrye, beardless	*E. triticoides* Buckl.	Shoot DW	2.7	6.0	MT	Brown & Bernstein, 1953
Wildrye, Canadian	*E. canadensis* L.	Shoot DW	—	—	MT*	USSL staff, 1954
Wildrye, Russian	*E. junceus* Fisch.	Shoot DW	—	—	T	McElgunn & Lawrence, 1973

Table 1: Salt Tolerance of Herbaceous Crops[1] (continued)

Crop		Salt tolerance parameters				References
Common name	Botanical name[‡]	Tolerance based on:	Threshold[¶] (Ec_e)	Slope dS/m	Rating[#] % per dS/m	
Vegetables and fruit crops						
Artichoke	*Cynara scolymus* L.	Bud yield	6.1	11.5	MT	Francois, 1995
Asparagus	*Asparagus officinalis* L.	Spear yield	4.1	2.0	T	Francois, 1987
Bean, common	*Phaseolus vulgaris* L.	Seed yield	1.0	19	S	Bernstein & Ayers, 1951; Hoffman & Rawlins, 1970; Magistad et al., 1943; Nieman &, 1959; Osawa, 1965
Bean, lima	*P. lunatus* L.	Seed yield	—	—	MT*	Mahmoud et al., 1988
Bean, mung	*Vigna radiate* (L.) R. Wilcz.	Seed yield	1.8	20.7	S	Minhas et al., 1990
Cassava	*Manihot esculenta* Crantz	Tuber yield	—	—	MS	Anonymous, 1976;Hawker & Smith, 1982
Beet, red[†††]	*Beta vulgaris* L.	Storage root	4.0	9.0	MT	Bernstein et al., 1974; Hoffman & Rawlins, 1971; Magistad et al., 1943
Broccoli	*Brassica oleracea* L. (Botrytis group)	Shoot FW	2.8	9.2	MS	Bernstein & Ayers, 1949a (p. 39); Bernstein et al., 1974
Brussel Sprout	*B. oleracea* L. (Gemmifera Group)		—	—	MS*	
Cabbage	*B. oleracea* L. (Capitata Group)	Head FW	1.8	9.7	MS	Bernstein & Ayers, 1949a (p. 39); Bernstein et al., 1974; Osawa, 1965
Carrot	*Daucus carota* L.	Storage root	1.0	14	S	Bernstein & Ayers, 1953a; Bernstein et al., 1974; Lagerwerff & Holland, 1960; Magistad et al., 1943; Osawa, 1965
Cauliflower	*Brassica oleracea* L. (Botrytis Group)		—	—	MS*	
Celery	*Apium graveolens* L. var Dulce (Mill.) Pers.	Petiole FW	1.8	6.2	MS	Francois & West, 1982
Corn, sweet	*Zea mays* L.	Ear FW	1.7	12	MS	Bernstein & Ayers, 1949b (p. 41-42)
Cowpea	*Vigna unguiculata* (L.) Walp.	Seed yield	4.9	12	MT	West & Francois, 1982
Cucumber	*Cucumis sativus* L	Fruit yield	2.5	13	MS	Osawa, 1965; Ploegman & Bierhuizen, 1970
Eggplant	*Solanum melongena* L. var *esculentum* Nees.	Fruit yield	1.1	6.9	MS	Heuer et al., 1986
Garlic	*Allium sativum* L.	Bulb yield	3.9	14.3	MS	Francois, 1994b
Gram, black Or Urd bean	*Vigna mungo* (L.) Hepper [syn. *Phaseolus mungo* L.]	Shoot DW	—	—	S	Keating & Fisher, 1985
Kale	*Brassica oleracea* L. (Acephala Group)		—	—	MS*	Malcolm & Smith, 1971
Kohlrabi	*Brassica oleracea* L (Gongylodes Group)		—	—	MS*	
Lettuce	*Lactuca sativa* L.	Top FW	1.3	13	MS	Ayers et al., 1951; Bernstein et al., 1974; Osawa, 1965
Muskmelon	*Cucumis melo* L. (Reticulatus Group)	Fruit Yield	1.0	8.4	MS	Mangal et al., 1988 Shannon & Francois, 1978
Okra	*Abelmoschus esculentus* (L.) Moench	Pod yield	—	—	MS	Masih et al., 1978; Paliwal & Maliwal, 1972
Onion (bulb)	*Allium cepa* L.	Bulb yield	1.2	16	S	Bernstein & Ayers, 1953b; Bernstein et al., 1974; Hoffman & Rawlins, 1971; Osawa, 1965

Table 1: Salt Tolerance of Herbaceous Crops[1] (continued)

Crop		Salt tolerance parameters				References
Common name	Botanical name‡	Tolerance based on:	Threshold¶ (Ec_e)	Slope dS/m	Rating# % per dS/m	
Vegetables and fruit crops						
Onion (seed)	*Allium cepa* L	Seed yield	1.0	8.0	MS	Mangal et al., 1989
Parsnip	*Pastinaca sativa* L.		—	—	S*	Malcolm & Smith, 1971
Pea	*Pisium sativum* L.	Seed FW	3.4	10.6	MS	Cerda et al., 1982
Pepper	*Capsicum annuum* L.	Fruit yield	1.5	14	MS	Bernstein, 1954 (p. 36-37); Osawa, 1965, USSL‡‡
Pigeon pea	*Cajanus cajan* (L.) Huth [syn. *C. indicus* (K.) Spreng.]	Shoot DW	—	—	S	Keating & Fisher, 1985; Subbarao et al., 1991
Potato	*Solanum tuberosum* L.	Tuber yield	1.7	12	MS	Bernstein et al., 1951
Pumpkin	*Cucurbita pepo* L var. *Pepo*		—	—	MS*	
Purslane	*Portulaca oleracea* L.	Shoot FW	6.3	9.6	MT	Kumamoto et al., 1992
Radish	*Raphanus sativus* L.	Storage root	1.2	13	MS	Hoffman & Rawlins, 1971; Osawa, 1965
Spinach	*Spinacia oleracea* L.	Top FW	2.0	7.6	MS	Langdale et al., 1971; Osawa, 1965
Squash, scallop	*Cucurbita pepo* L. var *melopepo* L. Alef.	Fruit yield	3.2	16	MS	Francois, 1985
Squash, zucchini	*C. pepo* L. var *melopepo* (L.) Alef.	Fruit yield	4.9	10.5	MT	Francois, 1985; Graifenberg et al., 1996
Strawberry	*Fragaria x ananassa* Duch.	Fruit yield	1.0	33	S	Ehlig & Bernstein, 1958; Osawa, 1965
Sweet potato	*Ipomoea batatas* (L.) Lam.	Fleshy root	1.5	11	MS	Greig & Smith, 1962; USSL‡‡
Tepary bean	*Phaseolus acutifolius* Gray		—	—	MS*	Goertz & Coons, 1991; Hendry, 1918; Perez & Minguez, 1985
Tomato	*Lycopersicon lycopersicum* (L.) Karst. Ex Farw. [syn. *Lycopersicon esculentum* Mill.]]	Fruit yield	2.5	9.9	MS	Bierhuizen & Ploegman, 1967; Hayward & Long, 1943; Lyon, 1941; Shalhevet & Yaron, 1973
Tomato, cherry	*L. lycopersicum* var. *Cerasiforme* (Dunal) Alef.	Fruit yield	1.7	9.1	MS	Caro et al., 1991
Turnip	*Brassica rapa* L. (Rapifera Group)	Storage root	0.9	9.0	MS	Francois, 1984a
Turnip (greens)		Top FW	3.3	4.3	MT	Francois, 1984a
Watermelon	*Citrullus lanatus* (Thunb. Matsum. & Nakai	Fruit yield	—	—	MS*	de Forges, 1970
Winged bean	*Psophocarpus tetragonolobus* L. DC	Shoot DW	—	—	MT	Weil & Khalil, 1986

† These data serve only as a guideline to relative tolerances among crops. Absolute tolerances vary, depending upon climate, soil conditions, and cultural practices.
‡ Botanical and common names follow the convention of Hortus Third (Liberty Hyde Bailey Hortorium Staff, 1976) where possible.
§ FW = fresh weight, DW = dry weight.
¶ In gypsiferous soils, plants will tolerate EC_e's about 2dS/m higher than indicated.
# Ratings are defined by the boundaries in Fig. 3-3. (Ratings with an * are estimates.)
†† Less tolerant during seedling stage, EC_e at this stage should not exceed 4 or 5 dS/m.
‡‡ Unpublished U.S. Salinity Laboratory data.
§§ Grain and forage yields of DeKalb XL-75 grown on an organic muck soil decreased about 26% per deciSiemen/meter above athreshold of 1.9 dS/m (Hoffman et al., 1983).
¶¶ Because paddy rice is grown under flooded conditions, values refer to the electrical conductivity of the soil water while the pants are submerged. Less tolerant during seedling stage.
Sesame cultivars, Sesaco 7 and 8, may be more salt tolerant than indicated by the S rating.
††† Sensitive during germination and emergence, EC_e should not exceed 3 dS/m.
‡‡‡ Data from one cultivar, Probred.
§§§ Average of several varities. Suwannee and Coastal are about 20% more tolerant, and common and Greenfield are about 20% less tolerant than the average.
¶¶¶ Average for Boer, Wilman, Sand, and Weeping cultivars (Lehman seems about 50% more tolerant).

Table 2: Salt Tolerance of Woody Crops†

Crop		Salt tolerance parameters				References
Common name	**Botanical name‡**	**Tolerance based on:**	**Threshold¶ (Ec_e)**	**Slope dS/m**	**Rating# % per dS/m**	
Almond	*Prunus duclis* (Mill.) D.A. Webb	Shoot growth	1.5	19	S	Bernstein et al., 1956; Brown et al., 1953
Apple	*Malus sylvestris* Mill.		—	—	S	Ivanov, 1970
Apricot	*Prunus armeniaca* L.	Shoot growth	1.6	24	S	Bernstein et al., 1956
Avocado	*Persea americana* Mill.	Shoot growth	—	—	S	Ayers, 1950a; Haas, 1950
Banana	*Musa acuminata* Colla	Fruit yield	—	—	S	Israeli et al., 1986
Blackberry	*Rubus macropetalus* Doug. ex Hook	Fruit yield	1.5	22	S	Ehlig, 1964
Boysenberry	*Rubrus ursinus* Cham. and Schlechtend	Fruit yield	1.5	22	S	Ehlig, 1964
Castorbean	*Ricinus communis* L.		—	—	MS*	USSL staff, 1954
Cherimoya	*Annona cherimola* Mill.	Foliar injury	—	—	S	Cooper et al., 1952
Cherry, sweet	*Prunus avium* L.	Foliar injury	—	—	S*	Beeftink, 1955
Cherry, sand	*Prunus besseyi* L., H. Baley	Foliar injury, stem growth	—	—	S*	Zhemchuzhnikov, 1946
Coconut	*Cocos nucifera* L.		—	—	MT*	Kulkarni et al., 1973
Currant	*Ribes sp.* L	Foliar injury, stem growth	—	—	S*	Beeftink, 1955; Zhemchuzhnikov, 1946
Date palm	*Phoenix dactylifera* L.	Fruit yield	4.0	3.6	T	Furr & Armstrong, 1962; (p. 11-13); Furr & Ream, 1968; Furr et al., 1966
Fig	*Ficus carica* L.	Plant DW	—	—	MT*	Patil & Patil, 1983a; USSL staff, 1954
Gooseberry	*Ribes sp.* L.		—	—	S*	Beeftink, 1955
Grape	*Vitis vinifera* L.	Shoot growth	1.5	9.6	MS	Groot Obbink & Alexander, 1973; Nauriyal & Gupta, 1967; Taha et al., 1972
Grapefruit	*Citrus x paradisi* Macfady.	Fruit yield	1.2	13.5	S	Bielorai et al., 1978
Guava	*Psidium guajava* L.	Shoot and root growth	4.7	9.8	MT	Patil et al., 1984
Guayule	*Parthenium argentatum* A. Gray	Shoot DW rubber yield	8.7 7.8	11.6 10.8	T T	Maas et al., 1988
Jambolan plum	*Syzgium cumini* L.	Shoot growth	—	—	MT	Patil & Patil, 1983b
Jojoba	*Simmondsia chinensis* (Link) C.K. Schneid	Shoot growth	—	—	T	Tal et al., 1979; Yermanos et al., 1967
Jujube, Indian	*Ziziphus mauritiana* Lam.	Fruit yield	—	—	MT	Hooda et al., 1990
Lemon	*Citrus limon* (L.) Burm. F.	Fruit yield	1.5	12.8	S	Cerda et al., 1990
Lime	*Citrus aurantiifolia* (Christm.) Swingle		—	—	S*	
Loquat	*Eriobotrya japonica* (Thunb.) Lindl.	Foliar injury	—	—	S*	Cooper & Link, 1953; Malcolm & Smith, 1971
Macadamia	*Macadamia integrifolia* Maiden & Betche	Seedling growth	—	—	MS*	Hue & McCall, 1989
Mandarin orange; tangerine	*Citrus reticulata* Blanco	Shoot growth	—	—	S*	Minessy et al., 1974
Mango	*Mangifera indica* L.	Foliar injur	—	—	S	Cooper et al., 1952

Table 2: Salt Tolerance of Woody Crops[†] (continued)

Crop		Salt tolerance parameters				References
Common name	Botanical name[‡]	Tolerance based on:	Threshold[¶] (Ec_e)	Slope dS/m	Rating[#] % per dS/m	
Natal plum	*Carissa grandiflora* (E.H. Mey.) A. DC.	Shoot growth	—	—	T	Bernstein et al., 1972
Olive	*Olea europaea* L.	Seedling growth, fruit yield	—	—	MT	Bidner-Barhava & Ramati, 1967; Taha et al., 1972
Orange	*Citrus sinensis* (L.) Osbeck	Fruit yield	1.3	13.1	S	Bielorai et al., 1988; Bingham et al., 1974; Dasberg et al., 1991; Harding et al., 1958
Papaya	*Carica papaya* L.	Seedling growth, foliar injury	—	—	MS	Kottenmeier et al., 1983; Makhija & Jindal, 1983
Passion fruit	*Passiflora edulis* Sims.		—	—	S*	Malcolm & Smith, 1971
Peach	*Prunus persica* (L.) Batsch	Shoot growth, fruit yield	1.7	21	S	Bernstein et al., 1956 Brown et al., 1953; Hayward et al., 1946
Pear	*Pyrus communis* L.		—	—	S*	USSL staff, 1954
Pecan	*Carya illinoinensis* (Wangeth) C. Koch	Nut yield trunk growth	—	—	MS	Miyamoto et al., 1986
Persimmon	*Diospyros virginiana* L.		—	—	S*	Malcolm & Smith, 1971
Pineapple	*Ananas comosus* (L.) Merrill	Shoot DW	—	—	MT	Wambiji & El-Swaify, 1974
Pistachio	*Pistachia vera* L.	Shoot growth	—	—	MS	Sepaskhah & Maftoun, 1988; Picchioni et al., 1990
Plum; prune	*Prunus domestica* L.	Fruit yield	2.6	31	MS	Hoffman et al., 1989
Pomegranate	*Punica granatum* L.	Shoot growth	—	—	MS	Patil & Patil, 1982
Popinac, white	*Leucaena leucocephala* (Lam.) De Wit [syn. *Leucaena glauca* Benth.]	Shoot DW	—	—	MS	Gorham et al., 1988; Hansen & Munns, 1988
Pummelo	*Citrus maxima* (Burm.)	Foliar injury	—	—	S*	Furr & Ream, 1969
Raspberry	*Rubus idaeus* L.	Fruit yield	—	—	S	Ehlig, 1964
Rose apple	*Syzgium jambos* (L.) Alston	Foliar injur	—	—	S*	Cooper & Gorton, 1951 (p. 32-38)
Sapote, white	*Casimiroa edulis* Llave	Foliar injur	—	—	S*	Cooper et al., 1952
Scarlet wisteria	*Sesbania grandiflora*	Shoot DW	—	—	MT	Chavan & Karadge, 1986
Tamarugo	*Prosopis tamarugo* Phil.	Observation	—	—	T	Natl. Acad. Sci., 1975
Walnut	*Juglans* spp.	Foliar injury	—	—	S*	Beeftink, 1955

[†] These data serve only as a guideline to relative tolerances among crops. Absolute tolerances vary, depending upon climate, soil conditions, and cultural practices. The data are applicable when rootstocks are used that do not accumulate Na^+ or Cl^- rapidly or when these ions do not predominate in the soil.

[‡] Botanical and common names follow the convention of Hortus Third (Liberty Hyde Bailey Hortorium Staff, 1976) where possible.

[§] In gypsiferous soils, plants will tolerate EC_e's about 2 dS/m higher than indicated.

[¶] Ratings are defined by the boundaries in Fig. 3-3. Ratings with an * are estimates.

Table 3: Boron tolerance limits for agricultural crops.

Crop		Boron tolerance parameters				References
Common name	Botanical name	Tolerance[†] based on:	Threshold[‡] g m-3	Slope % per g m-3	Rating[§]	
Alfalfa	*Medicago sativa* L.	Shoot DW	4.0-6.0		T	Eaton, 1944
Apricot	*Prunus armeniaca* L.	Leaf & stem injury	0.5-0.75		S	Woodbridge, 1955
Artichoke, globe	*Cynara scolymus* L.	Laminae DW	2.0-4.0		MT	Eaton, 1944
Artichoke, Jerusalem	*Helianthus tuberosus* L.	Whole plant DW	0.75-1.0		S	Eaton, 1944
Asparagus	*Asparagus officinalis* L.	Shoot DW	10.0-15.0		VT	Eaton, 1944
Avocado	*Persea americana* Mill.	Foliar injury	0.5-0.75		S	Haas, 1929
Barley	*Hordeum vulgare* L.	Grain yield	3.4	4.4	MT	Bingham et al., 1985
Bean, kidney	*Phaseolus vulgaris* L.	Whole plant DW	0.75-1.0		S	Eaton, 1944
Bean, lima	*Phaseolus lunatus* L.	Whole plant DW	0.75-1.0		S	Eaton, 1944
Bean, mung	*Vigna radiata* L. R. Wilcz.	Shoot length	0.75-1.0		S	Khundairi, 1961
Bean, snap	*Phaseolus vulgaris* L.	Pod yield	1.0	12	S	Francois, 1989
Beet, red	*Beta vulgaris* L.	Root DW	4.0-6.0		T	Eaton, 1944
Blackberry	*Rubus sp.* L	Whole plant DW	<0.5		VS	Eaton, 1944
Bluegrass, Kentucky	*Poa pratensis* L.	Leaf DW	2.0-4.0		MT	Eaton, 1944
Broccoli	*Brassica oleracea* L. (Botrytis group)	Head FW	1.0	1.8	MS	Francois, 1986
Cabbage	*Brassica oleracea* L. (Capitata group)	Whole plant DW	2.0-4.0		MT	Eaton, 1944
Carrot	*Daucus carota* L.	Root DW	1.0-2.0		MS	Eaton, 1944
Cauliflower	*Brassica oleracea* L. (Botrytis group)	Curd FW	4.0	1.9	MT	Francois, 1986
Celery	*Apium graveolens* L. var. dulce (Mill.) Pers.	Petiole FW	9.8	3.2	VT	Francios, 1988
Cherry	*Prunus avium* L.	Whole plant DW	0.5-0.75		S	Eaton, 1944
Clover, sweet	*Melilotus indica* All.	Whole plant DW	2.0-4.0		MT	Eaton, 1944
Corn	*Zea mays* L.	Shoot DW	2.0-4.0		MT	El-Sheikh et al., 1971
Cotton	*Gossypium hirsutum* L.	Boll DW	6.0-10.0		VT	Eaton, 1944
Cowpea	*Vigna unguiculata* (L.) Walp.	Seed yield	2.5	12	MT	Francois, 1989
Cucumber	*Cucumis sativus* L.	Shoot DW	1.0-2.0		MS	El-Sheikh et al., 1971
Fig, kadota	*Ficus carica* L.	Whole plant DW	0.5-0.75		S	Eaton, 1944
Garlic	*Allium sativum* L.	Bulb yield	4.3	2.7	T	Francois, 1991
Grape	*Vitis vinifera* L.	Whole plant DW	0.5-0.75		S	Eaton, 1944
Grapefruit	*Citrus x paradisi* Macfady.	Foliar injury	0.5-0.75		S	Haas, 1929
Lemon	*Citrus limon* (L.) Burm. f.	Foliar injury, plant DW	<0.5		VS	Eaton, 1944; Haas, 1929
Lettuce	*Lactuca sativa* L.	Head FW	1.3	1.7	MS	Francois, 1988
Lupine	*Lupinus hartwegii* Lindl.	Whole plant DW	0.75-1.0	S		Eaton, 1944
Muskmelon	*Cucumis melo* L. (Reticulatus group)	Shoot DW	2.0-4.0		MT	Eaton, 1944; El- Sheikh et al.,1971
Mustard	*Brassica juncea* Coss.	Whole plant DW	2.0-4.0		MT	Eaton, 1944
Oat	*Avena sativa* L.	Grain (immature) DW	2.0-4.0		MT	Eaton, 1944
Onion	*Allium cepa* L.	Bulb yield	8.9	1.9	VT	Francois, 1991
Orange	*Citrus sinensis* (L.) Osbeck	Foliar injury	0.5-0.75		S	Haas, 1929
Parsley	*Petroselinum crispum* Nym.	Whole plant DW	4.0-6.0		T	Eaton, 1944
Pea	*Pisum sativa* L.	Whole plant DW	1.0-2.0		MS	Eaton, 1944
Peach	*Prunus persica* (L.) Batsch.	Whole plant DW	0.5-0.75		S	Eaton, 1944; Haas, 1929

Table 3: Boron tolerance limits for agricultural crops. (Continued)

Crop		Boron tolerance parameters				
Common name	Botanical name	Tolerance† based on:	Threshold‡ g m-3	Slope % per g m-3	Rating§	References
Peanut	*Arachis hypogaea* L.	Seed yield	0.75-1.0		S	Gopal, 1971
Pecan	*Carya illinoinensis* (Wangenh.) C. Koch	Foliar injury	0.5-0.75		S	Haas, 1929
Pepper, red	*Capsicum annuum* L.	Fruit yield	1.0-2.		MS	Eaton, 1944
Persimmon	*Diospyros kaki* L.f.	Whole plant DW	0.5-0.75		S	Eaton, 1944
Plum	*Prunus domestica* L.	Leaf & stem injury	0.5-0.75		S	Woodbridge, 1955
Potato	*Solanum tuberosum* L.	Tuber DW	1.0-2.0		MS	Eaton, 1944
Radish	*Raphanus sativus* L.	Root FW	1.0	1.4	MS	Francois, 1986
Sesame	*Sesamum indicum* L.	Foliar injury	0.75-1.0		S	Khundairi, 1961
Sorghum	*Sorghum bicolor* (L.)	Grain yield	7.4	4.7	VT	Bingham et al., Moench 1985
Squash, scallop	*Curcurbita pepo* L. *var melopepo* (L.) Alef.	Fruit yield	4.9	9.	T	Francois, 1992
Squash, winter	*Curcurbita moschata Poir*	Fruit yield	1.0	4.3	MS	Francois, 1992
Squash, zucchini	*Curcurbita pepo* L. *var melopepo* L. Alef.	Fruit yield	2.7	5.2	MT	Francois, 1992
Strawberry	*Fragaria sp*. L.	Whole plant DW	0.75-1.0		S	Eaton, 1944
Sugar beet	*Beta vulgaris* L.	Storage root FW	4.9	4.1	T	Vlamis & Ulrich, 1973
Sunflower	*Helianthus annuus* L.	Seed yield	0.75-1.0		S	Pathak et al., 1975
Sweet potato	*Ipomoea batatas* (L.) Lam.	Root DW	0.75-1.0		S	Eaton, 1944
Tobacco	*Nicotiana tobacum* L.	Laminae DW	2.0-4.0		MT	Eaton, 1944
Tomato	*Lycopersicon lycopersicum* (L.) Karst. ex Farw.	Fruit yield	5.7	3.4	T	Francois, 1984b
Turnip	*Brassica rapa* L. (Rapifera	Root DW group)	2.0-4.0		MT	Eaton, 1944
Vetch, purple	*Vicia benghalensis* L.	Whole plant DW	4.0-6.0		T	Eaton, 1944
Walnut	*Juglans regia* L.	Foliar injury	0.5-0.75		S	Haas, 1929
Wheat	*Triticum aestivum* L.	Grain yield	0.75-1.0	3.3	S	Bingham et al., 1985; Khundairi, 1961

† FW = fresh weight, DW = dry weight.

‡ Maximum permissible concentration in soil water without yield reduction. Boron tolerances vary, depending upon climate, soil conditions, and crop varieties.

§ The B tolerance ratings are based on the following threshold concentration ranges: <0.5 g m^{-3} very sensitive (VS), 0.5 to 1.0 g m^{-3} sensitive (S), 1.0 to 2.0 g m^{-3} moderately sensitive (MS), 2.0 to 4.0 g m^{-3} moderately tolerant (MT), 4.0 to 6.0 g m^{-3} tolerant (T), and >6.0 g m^{-3} very tolerant (VT).

Sources for Plant Materials

Government-Forages or Halophytes

1. USDA Plant Materials Center (PMC), Lockeford California. (209) 727-5319.
2. Westside Resource Conservation District (WSRCD). (559) 227-2489.

Commercial*— Salt Tolerant Forages

1. America's Alfalfa. Tel: (800) 873-2532.

Material: 'Salado' and 'Ameristand 801S' salt tolerant alfalfa.

2. K-F Seeds. 4307 Fifield Road. Brawley, CA 92227. Tel: (760) 344-6391, FAX: (760) 344-6394. Material: Bermudagrass seed. Varieties 'Giant' and 'Common'.

'Tifton' is also recommended, but may not be available from this company.

3. S&W Seed Co. P.O. Box 235, Five Points, CA 93624. Tel: (559) 884-2535 swseedco@pacbell.net. Web: www.swseedco.com

Materials: "Westside Wheatgrass", a commercialized variety of 'Jose' Tall Wheatgrass and "SW 9720' Salt tolerant alfalfa.

4. West Coast Turf. PO Box 4563, Palm Desert, CA 92261. Tel: (800) 447-1840, (760) 346-TURF, and FAX: (760) 360.5616. Material: Seashore Paspalum ('SeasIsle 1') sod or chopped stolons.

Commercial*— Halophytes

1. NyPa International. Dr. Nick Yensen. 727 N. Ninth Ave., Tucson, Arizona 85705. Tel: 520 624-7245, FAX: 520-908-0819, email: nypa@aol.com web: http://expage.com/nypa.

Materials: "NyPa forage", a commercialized saltgrass (Distichlis spicata).

Tulare Lake Drainage District, Corcoran, CA (tel. 559-992-3145) may also be contacted to obtain NyPa forage.

2. Saline Seed, Inc. Contact: Mr. Daniel Murphy, 1900 Mountain Valley Lane Escondido, California 92029. Tel: 760-294-3079, Fax: 760-294-3081, e-mail danielmurphyusa@yahoo.com. Web: http://salicornia.com/

Materials: Salicornia and other halophytes and salt tolerant forages.

*List is not inclusive and does not represent an endorsement of these companies.

IFDM Plant Management Guide

Clarence Finch & Frank Menezes
With revisions by Sharon Benes and Vashek Cervinka (12-2003)

Salt-tolerant Grasses and Halophytes

This guide uses the term "salt-tolerant grasses" for plants tolerating drainage water of EC from 8 to 15 dS/m, and the term "halophytes" for plants tolerating drainage water above EC 15 dS/m. Using water salinity of EC 15 as a separating limit is rather artificial, but it can be said that halophytes tolerate higher salinity than salt-tolerant grasses.

This selection of forages, halophytes, and trees for saline drainage management for the Westside San Joaquin Valley was based on literature review from the USA, Australia, Israel, and other countries, field evaluation trials, and a survey of salt-tolerant plants in semi-arid world regions. The set of plants used in both areas is the result of a multiple-year selection process. These plants are being selected not only for salt management purposes, but also for their biological interaction with conventional farm crops to avoid introducing species that could be potential weeds or host plants for insect vectors of plant viruses.

Salt-tolerant grasses and halophytes should preferably be perennial plants to manage higher flows of drainage water during the winter/spring period. The other required characteristics include high water demand, tolerance to frequent flooding, frost tolerance, and marketability of harvested biomass. Salt-tolerant grasses and halophytes are mainly used for the re-use of drainage water so as to reduce its volume. They are grown on a relatively small area of the farm (2%-8%). Trees are most commonly used in strips to intercept subsurface lateral flows of groundwater and/or to locally drop the water table. Commercial value is of primary importance for the areas under irrigation with freshwater or low salinity water where vegetables and salt-tolerant field crops (cotton, wheat, canola, sugar beets, and possibly, alfalfa) are grown. However, economic value can be a secondary consideration in the selection of salt-tolerant grasses, halophytes, and trees.

Recommended plant management

Prepare soil by leveling the planting area to achieve uniform water distribution in the fields of salt-tolerant grasses and halophytes. This is essential for plant growth and salt leaching, as well as for minimizing water ponding that could potentially attract wildlife. When establishing the plants in an area with slope, divide this the area into blocks by throwing up borders (ridges of soil) to confine the water and level each block for uniform water distribution. If an area is too steep to level to a uniform grade for irrigation and leaching, use sprinklers to irrigate. Good stands require weed-free soil conditions.

Establish plants by seeding or by planting rooted plants (plugs). Use a drill on a "vegetable type" seedbed or on a seedbed prepared with a corrugated roller. Broadcast seed on a leveled, disked corrugated surface of shallow furrow (such as tomato beds). It is recommended to plant plugs in the bottom of the rills (furrows). This reduces the salt load around the base of the plants and allows water to reach the plants more quickly. Alternatively, in a raised bed system, the seed or cuttings should be placed on the edges of the bed, avoiding the center of the bed which is the zone of maximum salt accumulation.

There are a number of methods for planting rooted plants such as by shovel, dibble, or by a mechanical vegetable planter. The most successful method is either the tree planter or the vegetable planter because they open up the soil, and the plant is placed deeper in the soil. Timing of planting is very important. Cool season grasses should be planted in the fall. Warm season plants in the spring.

When planting rooted plants, irrigation should follow as soon as possible after planting. Fresh water (less than 3 dS/m) should be used to irrigate until salt-tolerant plants are well established. Some perennials have to be planted and established for about a year before applying water over 10 dS/m. Salicornia and other halophytes may require saline water to be established. Once plants are established, border (flood) irrigation is recommended to effectively leach salts. Sprinklers are also effective for leaching salts below the root zone and/or on land that is too steep to flood. Irrigation frequency depends on plant, soil, and climatological conditions. Cycles of watering and drying are important. Yellowing of plants may be caused by over-watering or salt build-up.

Mowing helps to control weeds. Mowing height can be critical to plant survival. The following are the recommended mowing heights for plants:

Bermudagrass and Saltgrass
10 cm (4 inches)

Tall Wheatgrass, Alkali Sacaton, Beardless wildrye, 20 to 25 cm (8 to 10 inches) and Cordgrass

Atriplex and Allenrolfea 25 to 50 cm (10 to 20 inches)

Harvest salt-tolerant grasses and halophytes for hay or seeds. Grazing can be a preferable method of management. Do not graze when soils are wet, as compaction will reduce water infiltration.

Salt Tolerant Grasses and Halophytes
(Brief Description)

Jose Tall Wheatgrass (Elytrigia elongata) (Agropyron elongatum)

Tall wheatgrass is a tall growing, erect, late maturing, perennial bunch grass. Plants range from 60 to 150 cm (2 to 5 feet) tall and the grass produces large erect seed heads that develop a good crop of seed. Growth starts in the spring and continues into late summer. The plant can be established in the fall by broadcast or drill, on a weed-free firm seedbed. Good stands can be established on saline-alkali sites by planting in bottoms of furrows and irrigating every 4 to 5 days until the seedlings have emerged to a height of 10 to 15 cm (4 to 6 inches). Established plants have been growing in soils with up to ECe of about 25 dS/m. It can be irrigated with drainage water of EC ranging from 8 to 13 dS/m. Tall wheatgrass is utilized by all kinds of livestock as pasture, hay

Jose Tall Wheatgrass

or silage. It is important to maintain a stubble height of 20 cm (8 inches) when cutting for hay, silage or mowing down old seed head growth. This plant is excellent habitat for wildlife providing safe escape and excellent nesting cover, especially for pheasants.

Creeping wildrye ('Rio'), also called Beardless wildrye (Leymus triticoides or Elymus triticoides).

Creeping wildrye is a native perennial grass 60 to 150 cm (2 to 5 feet) tall growing singly or in small clumps. Due to its scaly underground rhizomes, it often spreads over large areas. While most native stands do not produce viable seed, the 'Rio' selection consistently produces viable seed. The plant can be established by seed in the fall, also by the underground rhizomes or by container grown plants. Established plants of creeping wildrye have been growing with EC 10 to 12 dS/m drain water. This forage is eaten by cattle and sheep and is excellent escape and nesting cover for wildlife.

Alkali Sacaton ('Salado') (Sporobolus airoides)

Alkali sacaton is a warm season native perennial bunchgrass. Plants range from 60 to 75 cm (2 to 2.5 feet) tall with curving leaves. Seed heads form a widely spreading panicle nearly one-half the entire height of the plant. Plants may be 20 to 30 cm (8 to 12 inches) in diameter at ground level. The plant is established in the spring by seed or container-grown plants. Due to small seed, a good firm moist seedbed is required. Established plants have been growing with EC of 10 to 14 dS/m

Creeping wildrye

Alkali Sacaton

drain water. Alkali sacaton is good forage for cattle and horses and fair for sheep. This forage is sometimes called "salado," which should not be confused with a new salt tolerant variety of alfalfa, also called "salado".

Koleagrass ('Perla') (Phalaris tuberosa var. hirtiglumis)

Koleagrass is a tall, robust, rapid developing perennial bunchgrass. Plants range from 60 to 150 cm (2 to 5 feet) tall with short stout rhizomes originating from the base. Perla is established in the fall by seeding on a firm, weed free seedbed, or by container-grown plants. Established plants have been growing with EC of 10 to 12 dS/m drain water. Perlagrass is a very palatable grass relished by all kinds of livestock. It starts growth in the fall with moisture and continues to grow into the winter months. Due to this growth habit the plant supplies fall and winter feed for livestock and excellent cover for wildlife, especially pheasants.

Tall Fescue ('Alta' and 'Goar') (Festuca arundinacea)

Tall Fescue is an aggressive, erect, deeply rooted perennial bunch grass. The plant is from 60 to 100 cm (2 to 3 feet) tall and produces heavy sod and fibrous root material. Growth starts in the spring and continues into late winter. The plant is established in the fall from seeds by broadcast or drill on a weed-free firm seedbed. Once established, it can be irrigated with drainage water of EC 8 to 12 dS/m. Tall fescue is utilized by all kinds of livestock as pasture or hay. It is an excellent shade and nesting cover for wildlife.

Bermuda grass

Bermuda grass is a perennial crop that is moderately salt tolerant, and drought resistant. It is established by seed and spreads by rhizomes. Bermuda grass forms dense turf and can be grazed or cut for hay harvesting.

Halophytes

Pickleweed ('Samphire') (Salicornia bigelovii)

Pickleweed is a low growing very succulent annual plant that is 15 to 38 cm (6 to 15 inches) tall with green scale-like leaves. The plant is established from seed by broadcast or drilling on a well- prepared firm seedbed, similar to establishing alfalfa stands. In fact, the seed is similar in size to alfalfa. Seeding is recommended after the frost period in the spring; however in the SJV, seed can be applied in the late fall / early winter: it will lie dormant and germinate in about March. The stand can be flood or sprinkler irrigated. The plant requires salty water of EC 20 to 30 dS/m. Surface soil in this stand may have an ECe as high as 50 dS/m. Salicornia can be irrigated with lower EC water, provided that the soil salinity is considerably higher than 20 dS/m; however, its growth and seed production will be less. Pickleweed may have multiple uses. One of its main uses is for seed production. When processed it produces oil which contains polyunsaturated fat close to the level of safflower oil and better than soybean oil. The meal from

Iodine Bush

Saltbush

the oil processing can be used as a feed source for poultry and livestock. The young top portions of the plant are used as a salad green and a tasty vegetable in areas of the world where it is irrigated with brackish water or with seawater.

Saltgrass (Distichlis spicata)

Saltgrass is a gray green to blue green, perennial grass with strong extensively creeping rhizomes. The mature plant can grow to 45 cm (18 inches) tall. The plant can be established by seed. The most common method of establishment is from rhizomes. Rhizomes can be single or chunks of sod. Plants establish much faster from sod. Spring establishment is the most desirable. Established plants have been growing in soils with an ECe of 30 dS/m. In its natural state plants are commonly found on roadsides, ditch banks and along salt marshes adjacent to coastal tidal marsh areas. The plant is grazed by livestock.

Cordgrass (Spartina species)

A perennial bunch-like, coarse-textured grass 30 to 100 cm (1 to 3 feet) tall and up to 30 to 75 cm (1 to 2.5 feet) thick at the base. Some plants have extensive creeping rhizomes. The plant can be established from rooted cuttings that were grown in plastic cone containers. Planting stock is taken from a clump of a mature plant and the small base of the plant is rooted in cone containers. Rooted plants can be established at any time of the year, but the best time is during the fall and spring. Cordgrass has been grown with drainage water with an EC of up to 35 dS/m. In its natural state, plants are growing in salt marshes and tidal flats. On the Atlantic coast, marsh hay consisting of mostly cordgrass is used for packing or bedding. The species of cordgrass grown are (Spartina alternaflora and Spartina gracilia) and 2 accessions of (Spartina patens) named ‘Flageo’ and ‘Avalon’ that has rhizomes.

Iodine bush (Allenrolfea occidentalis)

Iodine bush is an erect bush 30 to 180 cm (1 to 6 feet) tall, multiple branched. The green foliage is somewhat fleshy, with scale-like leaves. Establishment can be from seed or container-grown plants. Seed can be planted by broadcast or drill in late winter. Plantings in the fall can be made by seed, but weed competition at this time makes stand establishment difficult. Due to very small seed, the plants have very weak seedling vigor and a firm, weed-free condition must prevail during establishment. Container-grown plants can be established in the fall or spring. Seed can be easily harvested from native stands in the early winter. Established plants have been growing in soils with up ECe of 60 dS/m and with water of EC 30 dS/m. In its natural state, livestock have grazed the plant and have eliminated stands in dryland pastures when other vegetation has been used up. Its use in feed supplements has not been investigated extensively.

Saltbush (Atriplex species)

Atriplex is an erect spreading perennial shrub with dense foliage. It ranges from 2 to 6 feet in height and in width. Seed maturity is from October to December. The plant can be established from seed, bare-root or container-grown plants. Seed can be planted by broadcast or drill in late winter, January through March. A good firm seedbed is required. Broadcast seeding may appear inadequate the first year, but small plants at the end of the first year produce strong plants the second year. The best way to establish this shrub is from container-grown plants. Transplanting can be done in fall or spring. Established plants tolerate drainage water EC ranging from 28 to 30 dS/m. Livestock use Atriplex as browse or as a feed supplement, especially when fed in selenium deficient areas. In its natural state it provides excellent cover for upland game and rabbits. Atriplex can be a host for the sugar beet leafhopper, which may carry a virus that causes a curly top disease in sugar beets, and in vegetable crops like tomatoes, beans, and cantaloupe. Some of the Atriplex species used are A. lentiformis and A. nummularia.

Trees

Trees use and evaporate drainage water. This is achieved through the sequential reuse, by intercepting the flow of drainage water from upslope, or through the uptake of shallow groundwater. Trees can be viewed as biological pumps.

The role of Eucalyptus trees is to lower water tables and to occasionally receive reused drainage water, and thus, to assist in reducing the volume of drainage water to be managed.

Eucalyptus camaldulensis, River Red Gum, has been the superior tree selected and is now propagated as clones by a nursery in Southern California. The best Eucalyptus clones are 4573, 4543, and 4544. These are identification numbers assigned to selected trees by the Eucalyptus Improvement Association.

Both salt-tolerant plants and trees use drainage water and reduce its volume. The trees take up saline groundwater to lower water tables, intercept sub-surface water flows, sequentially reuse drainage water, and create a biological barrier between low-saline and high-saline areas. Drainage water is mainly applied to salt-tolerant plants and only occasionally to the trees (e.g., during high flows of drainage water).

Planting and care of trees

Three methods of planting trees to reduce saline conditions on cropland are used. The trees intercept subsurface water flow, consume

Eucalyptus

groundwater to lower water tables, and sequentially reuse drainage water. The tree blocks also serve as windbreaks, buffer strips, filter strips, and reduce dust problems.

The planting area should be leveled to avoid water ponding. Standing water can damage the trees and could become a potential environmental concern by attracting shore birds. If standing water can infiltrate or be drained off the area in three days or less, dead leveling may be an option. If dead leveling is not used, the recommended slope is .025/100 feet. If standing water is a problem at the end of the irrigation run, a tailwater return system is recommended to reduce tree loss from waterlogging. As with most trees or crops, eucalyptus trees perform best under optimum soil and water conditions with deep, well-drained soil.

Timing of plantation establishment is important for a complete drainage water reuse system. If fresh water or water less then EC 3 dS/m is available, then trees can be planted at the same time as halophytes.

Before planting trees, soils should be ripped or chiseled if the water table is not near the surface. Disk the area to control weeds and prepare soil for planting. Trees are planted in the bottom of furrows or on the leveled land. Planting the trees in the bottom of the furrows reduces salt load around the tree base as the sale accumulates on the top of the furrows. Planting the trees on the leveled land provides for the efficient salt leaching. Both methods can provide for the uniform distribution of water. Tree spacing within the row should be a minimum of eight feet. Tree row spacing will be determined by the width of equipment that will be used in the planting area. Allow two feet on each side of equipment (disk, mowers, spray rigs, etc.). For example, a 10-foot wide disk would require a row spacing of 14 feet. A wider spacing of 5 x 3 m (15 x 10 feet) is preferable. Trees can be planted using a mechanical tree planter. The ripper shank on the planter breaks up the soil and provides better root development for the new tree. If a tree planter is not available, hand planting can be done in a ripped or chiseled furrow. Proper spacing of trees is an advantage of hand planting.


Pistachio

Background information

In countries such as Australia, Egypt, Israel, and other arid regions, salt-tolerant trees have been irrigated with saline water. In 1985 the California Department of Food and Agriculture, the USDA-Soil Conservation Service, and the International Tree Crops Institute decided to try this concept in California. Eucalyptus seed was imported from the Province of Lake Albacutya in Victoria, Australia. The California Department of Forestry and private nurseries propagated seedlings.

Seedlings were first planted in Fresno and Kings Counties, primarily on farmland areas with high saline conditions that could not produce a crop. Survival was low on soils with high sodium levels. Sodium Absorption Ratios (SAR) exceeding 50 were primarily in Kings County.

In 1986 seedlings were propagated from seeds imported from Central Australia, Alice Springs, and surrounding areas. Some of these seedlings were interplanted in areas where the Lake Albacutya ones had died. They survived and selected trees were planted in areas with high saline and sodium conditions to determine their tolerance. Many other varieties of trees were planted in the same conditions. These included Eucalyptus from many provinces in Australia, Cottonwoods, Hybrid Cottonwoods, Athel, Salt cedar, Mesquite, Acacia, and Casurina obesa, cunninghamiana, glauca, and equisetifolia. Some of the varieties were irrigated with saline water of 6 to 20 dS/m and others with fresh water.

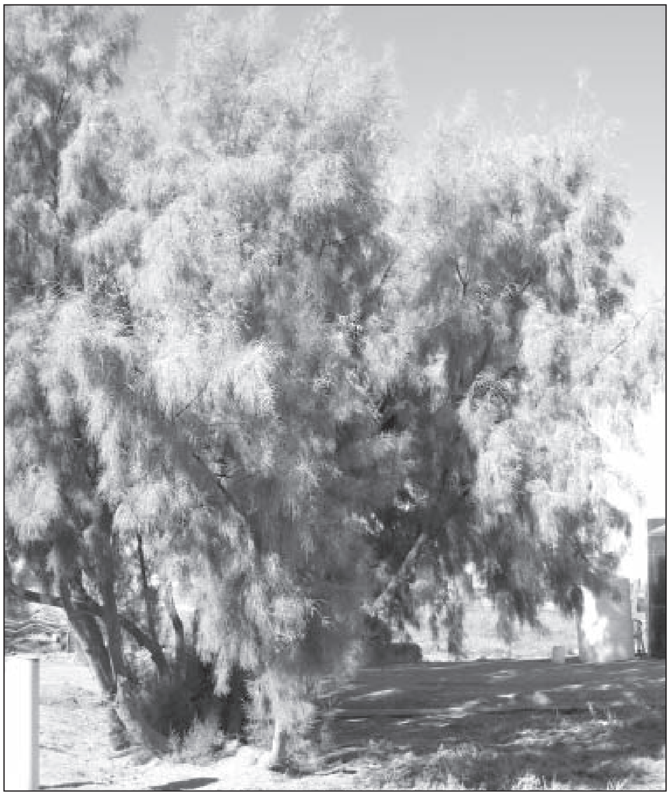
Other trees were also tried, including hybrid Willows and several varieties of Eucalyptus camaldulensis, rudis, robusta, occidentalis, grandis, viminalis, and tereticornis. Seedlings from old, established trees in Fresno and Kings Counties were also tried.

When the IFDM (Agroforestry) project started in the WRCD area (spring 1985), eucalyptus seeds were imported from Australia, Israel or Egypt, and the quality of propagated trees was inconsistent. To improve the quality of eucalyptus trees for IFDM/Agroforestry sites in the San Joaquin Valley, a selective breeding program was initiated in 1987. The IFDM/Agroforestry project team has worked closely with the California Eucalyptus Improvement Association (EIA) in its effort to coordinate the selection and propagation of superior trees. Trees are selected for salt tolerance, rate of growth, vigor, and frost tolerance. This selection effort has been successful, and most eucalyptus trees planted on irrigated farms since 1990 have been propagated from plant tissues and seeds developed in California. Selected trees have been systematically evaluated each year since 1989, and 22 trees have been chosen for tissue culture propagation. Two orchards have also been planted in experimental designs that facilitate the evaluation of growth characteristics of selected trees. Seed orchards have been established at several farms in the San Joaquin Valley, and at the USDA-NRCS Plant Material Center in Lockeford, California.

The IFDM program is oriented toward higher diversification of salt-tolerant trees and crops planted for salt management. Casuarina trees have been planted since 1985, but their performance has not always been satisfactory. Casuarina glauca is not frost tolerant; it was damaged by frost in 1990, and did not recover. Casuarina cumminghamiana has been frost damaged on several farms, and its recovery rate was lower than that of eucalyptus trees. Several individual trees performed very well under extremely difficult conditions (frost, salt, and drought). Athel (Tamarix aphylla) trees are well established in the valley, being mainly used as windbreaks. They are salt-tolerant and recover well from frost damage. They may be beneficial on farms where salinity levels are above EC 20. Eucalyptus seeds collected in 1994 from highly saline seeps in Australia and nearby surrounding areas are now being tested alongside the best clones.

Eucalyptus has been the most common salt-tolerant tree used for the management of salt and drainage. Positive results have been obtained from the management of trees over a 12-year period. Trees initially propagated on various sites in the Valley from seeds imported from Australia did not have uniform characteristics, as the growth rate and salt and frost tolerance varied significantly. The selection of superior trees through the valuable guidance of the Eucalyptus Improvement Association started in 1987/88. The best trees (4543, 4544, 4573, and 4590) were selected and are now propagated as clones by a nursery in Southern California. The selection and testing process continues with additional eucalyptus varieties.

Since 1985, more than 700,000 trees have been planted for the management of salt on irrigated farmland in the San Joaquin Valley. Eucalyptus camaldulensis is mainly planted at this time because of its salt tolerance, high water requirements, and relatively easy care.



Tamarisk (Athel)

The difference between Tamarisk Athel and Tamarisk Salt Cedar

Tamarisk Athel is an upright tree reaching up to 60 feet tall, with a dense spreading crown and several heavy large limbs. It is a fast-growing, evergreen tree. Its diameter is about 2.5 feet. The propagation method is vegetative. It commonly occurs on salt flats, springs, and other saline habitats. It is drought resistant and is tolerant of alkaline and saline soils. It uses large volume of water; a large tree can absorb about 200 gallons of groundwater per day. It does not colonize sites by seed.

Tamarisk Salt Cedar is a shrub growing up to 20 feet tall. It is considered a weed that produces a large amount of seeds and spreads in a wide area. It commonly occurs on salt flats, springs, and other saline habitats. It is drought resistant and is tolerant of alkaline and saline soils. It uses a large volume of water.

California Regional Water Quality Control Board
Central Valley Region
Robert Schneider, Chair

Winston H. Hickox
Secretary for Environmental Protection

Gray Davis
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Mr. Gerald Stoltenberg
Westside Resource Conservation District
P.O. Box 205
Five Points, CA 93624

18 April 2002

DRAINAGE WATER BLENDING, WESTSIDE RESOURCE CONSERVATION DISTRICT, FRESNO COUNTY

Thank you for your letter of 18 March 2002, which asks for clarification on the regulatory requirements for the blending of drainage water used for the irrigation of salt tolerant crops.

Drainage water is a waste that can create nuisance conditions and/or affect the beneficial uses of waters of the state. The Regional Water Quality Control Board, Central Valley Region, (Regional Board) regulates discharges of wastewater that can affect waters of the state, including waste used for irrigation by agriculture. Examples include: packing house wastewater, food processing wastewater, biosolids, municipal wastewater reclamation, etc. While the Regional Board has the authority to regulate this waste using Waste Discharge Requirements (WDRs), drainage water is generally reused for irrigation without formal regulatory controls. In fact, the beneficial reuse of the drainage water can often result in water quality benefits by reducing the discharge of pollutants to surface waters.

The Regional Board generally considers drainage water applied on-farm a Non Point Source (NPS) of pollutants. However, compliance with the Clean Water Act, the Porter-Cologne Water Quality Control Act (Division 7 of the California Water Code), and the Water Quality Control Plan for the Tulare Lake Basin, Second Edition, 1995 (Basin Plan) <u>is not</u> a voluntary choice. It is the Regional Board's responsibility to ensure compliance with these laws and regulations. The NPS strategy calls for three tiers of regulatory control. Tier 1: Self-Determined Implementation of Management Practices; Tier 2: Regulatory Based Encouragement of Management Practices; and Tier 3: Effluent Limitations and Enforcement Actions. Under Tier 1, the Westside Resource Conservation District could develop and implement workable solutions to NPS pollution control, which affords the opportunity to solve problems before more formal regulatory controls are taken. Potential problems can often be addressed through modifications in management measures that make formal regulatory control unnecessary. However, the reuse of drainage water must comply with the Basin Plan and State Water Resources Control Board Resolution No. 68-16, the State's "antidegradation" policy. The on-farm reuse of drainage water, if done properly and for beneficial use, should pose minimal threat to waters of the state. It may be possible to regulate the blending of drainage water for the irrigation of salt tolerant crops under the first tier if a demonstration can be made that the blended water is beneficially used for agricultural production. Examples of agricultural production would include the sale of a marketable crop or a crop grown for grazing. If the reuse of drainage water causes a nuisance, threatens to impair the beneficial uses of ground or surface waters, or is not beneficially used, then additional control and possibly enforcement actions may be needed.

The Regional Board considers the blending of drainage water to extend the water supply for agricultural production, a reasonable use of water. The blending of high quality water with poorer quality drainage water for its reuse on crops is generally accepted and encouraged. However, any operation that adds unusable drainage water to usable water and results in an unusable blend would probably be considered an unreasonable use of water.

In some cases, other regulations may apply. For example, the waste may be hazardous and subject to hazardous waste regulations contained in Title 22, California Code of Regulations, hazardous waste restrictions in the Basin Plan, and possibly the Resource Conservation and Recovery Act.

The Regional Board believes that a mechanism needs to be developed to ensure drainage water is used for agronomic benefit, protects water quality, and prevents nuisance conditions so that the discharge is not disposed of improperly. The challenge is to identify the potential problems that may develop with any reuse project and to develop practices that address the situation. Recently, you were awarded a Clean Water Act section 319(h) grant to develop an education and outreach program concerning Integrated On-Farm Drainage Management. The handbooks developed from that grant are required to outline the environmental and regulatory requirements, which should clarify what is necessary. The 319(h) grant should be used to identify management measures to achieve compliance with all applicable regulations.

If you have further questions please email or telephone Anthony Toto at totoa@rb5f.swrcb.ca.gov or (559) 445-6278.

LONNIE M. WASS
Supervising Engineer
RCE No. 38917

cc: Dr. Steve Schwarzbach, U.S. Fish and Wildlife Service, Sacramento
Ms. Frances McChesney, Office of Chief Counsel, State Water Resources Control Board, Sacramento
Mr. Walt Shannon, Division of Water Quality, State Water Resources Control Board, Sacramento
Mr. Dennis Westcot, Regional Water Quality Control Board, Sacramento
Mr. Bill Loudermilk, Department of Fish and Game, Fresno
Dr. Andy Gordus, Department of Fish and Game, Fresno
Ms. Paula Landis, Department of Water Resources, Fresno
Mr. John Shelton, Department of Water Resources, Fresno
Mr. Manucher Alemi, Department of Water Resources, Sacramento

California Regional Water Quality Control Board
Central Valley Region

NOTICE OF INTENT
TO COMPLY WITH THE CONDITIONS OF ARTICLE 9.7. Commencing with Section 25209.10 of the Health and Safety Code Integrated On-Farm Drainage Management

FACILITY

A. NAME OF FACILITY OR BUSINESS OPERATING THE FACILITY:______________________________

ADDRESS OF FACILITY:______________________________
Number and Street City Zip Code

COUNTY:______________________________

CONTACT PERSON:____________________ TELEPHONE NO.____________________

B. NAME OF LEGAL OWNER OF FACILITY:______________________________

ADDRESS OF LEGAL OWNER OF FACILITY:______________________________
Number and Street City Zip Code

CONTACT PERSON:____________________ TELEPHONE NO.____________________

C. NAME OF CONTACT PERSON TO RECEIVE REGIONAL BOARD CORRESPONDENCE:____________________

ADDRESS OF CONTACT PERSON:______________________________
Number and Street City Zip Code

TELEPHONE NO. OF CONTACT PERSON: ____________________

LOCATION OF SOLAR EVAPORATOR

NUMBER OF ACRES ________ SECTION ____, TOWNSHIP ____, RANGE ____. APN ________ COUNTY ________

Provide a map of the area of the complete IFDM system (including irrigated fields for reuse) and indicate location of solar evaporator, tile lines, and monitoring wells.

DESIGN OF SOLAR EVAPORATOR

Provide a technical report prepared by an appropriately-registered California professional for the design of the solar evaporator. The report should describe of the capacity and the equipment to operate the solar evaporator. Explain features to prevent inundation from a 100-year flood. Include the tile drain design and the soil properties such as permeability, grain size distribution, percent clay, etc.

MAXIMUM ANTICIPATED RATE OF DISCHARGE TO THE SOLAR EVAPORATOR ________

OPERATIONAL PLANS FOR COMPLIANCE

Provide a plan for compliance with the requirements of article 9.7. Plans must include measures to prevent standing water, mitigate wildlife impacts, and prevent migration of constituents from the solar evaporator into the vadose zone. Include weather data and a water balance sufficient to assess the likelihood of standing water, and supporting the design of the solar evaporator.

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) COMPLIANCE

HAS ANY CEQA DOCUMENT BEEN ADOPTED/CERTIFIED BY A LEAD AGENCY FOR THIS PROJECT?
______YES ______NO (IF YES, PLEASE ENCLOSE A COPY OF THE ADOPTION/CERTIFICATION)

IF NO, WILL ANY CEQA DOCUMENT BE PREPARED? ______YES ______NO

IF YES, WHO WILL PREPARE THE CEQA DOCUMENT? ______________________________

APPROXIMATE DATE OF COMPLETION__________________

CERTIFICATION

I HEREBY CERTIFY UNDER PENALTY OF PERJURY THAT THE INFORMATION PROVIDED IN THIS NOTICE OF INTENT AND IN ANY ATTACHMENTS IS TRUE AND ACCURATE TO THE BEST OF MY KNOWLEDGE. IN ADDITION, I CERTIFY THAT THE CONDITIONS OF ARTICLE 9.7 OF THE HEALTH AND SAFETY CODE WILL BE COMPLIED WITH.

______________________________ ______________________________
SIGNATURE OF OWNER OF FACILITY SIGNATURE OF OPERATOR OF FACILITY

______________________________ ______________________________
PRINT OR TYPE NAME PRINT OR TYPE NAME

______________________________ ______________________________
TITLE AND DATE TITLE AND DATE

Laws and Regulations referred to in Chapter 9

Chapter 9 briefly outlines the various laws and regulations that may apply to development of an IFDM system. Additional details for each law is discussed here:

California Environmental Quality Act (CEQA): The California Public Resource Code §21000-21006 establishes the legislative intent and policy supporting the CEQA environmental disclosure and review process for projects conducted in the State of California. Public Resource Code §21065 defines a project as:

"an activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment, and which is any of the following:

(a) An activity directly undertaken by any public agency.

(b) An activity undertaken by a person which is supported, in whole or in part, through contracts, grants, subsidies, loans, or other forms of assistance from one or more public agencies.

(c) An activity that involves the issuance to a person of a lease, permit, license, certificate, or other entitlement for use by one or more public agencies."

Any project that fits the above definition, whether undertaken by a private or public entity, is subject to the CEQA process. An overview of the CEQA process is illustrated in Figure 1. Early in the process, a lead agency is designated. Generally, the lead agency is the California government agency principally responsible for approving or carrying out a project. The lead agency is responsible for preparing all necessary environmental disclosure documentation, for assuring that the documentation is legally adequate, and for encouraging public participation. Other agencies, known as responsible agencies, also may be directly involved with the CEQA process. These agencies are legally responsible for some aspect of the project or resource in the project area and will provide input to the lead agency as the project is planned and CEQA documentation is prepared. It is common for public agencies with permitting authority over a project to serve as responsible agencies. Once a lead agency is designated, an IS is prepared to help determine whether the project could have any significant effect on the environment. If a significant effect is anticipated, an Environmental Impact Report (EIR) is written, otherwise a Negative Declaration is prepared.

CEQA documentation is prepared not only to fully inform decision makers about the details and any possible impacts of a project before deciding whether to proceed, but it's also prepared to fully inform the general public about a proposed project and any potential impacts. The public disclosure aspect of CEQA is stressed in the CEQA statute, and protocols that facilitate public disclosure and interaction are provided in the CEQA guidelines (http://www.ceres.ca.gov/).

Although the CEQA process is outlined and discussed in the guidelines, it is best to let someone with a strong CEQA background determine which level of environmental analysis is appropriate for the proposed project, and to then complete the necessary actions to ensure CEQA compliance.

National Environmental Policy Act (NEPA): NEPA requires incorporating environmental considerations into the planning process for all federal projects, and for projects requiring federal funding or permits.

The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality [CEQ]. *Sec. 2 [42 USC § 4321], Federal Code.*

Unlike CEQA, NEPA allows each federal agency to develop their own NEPA guidelines; however, the CEQA requires that each agency's NEPA policy integrate environmental impact analysis into project planning and environmental disclosure documents including:

EA's and Environmental Impact Statements (EIS). Like CEQA, public disclosure and interaction are mandated by NEPA.

Federal Clean Water Act: The act specifies that federal agencies identify reasonable alternatives to a proposed project along with the preferred alternative (the proposed project), as well as describing any anticipated impacts.

Typical activities that affect water quality may include but are not limited to:

- Discharge of process wastewater and commercial activities not discharged into a sewer (factory wastewater, cooling water, etc.)
- Confined animal facilities (e.g., dairies)
- Waste containments (landfills, waste ponds, etc.)
- Construction sites
- Boatyards
- Discharges of pumped groundwater and cleanup (underground tank cleanup, dewatering, spills)
- Material handling areas draining to storm drains
- Sewage treatment facilities
- Filling of wetlands
- Dredging, filling, and disposal of dredge wastes
- Waste to land

Various agencies have been granted regulatory authority over different aspects of the Clean Water Act. Sections of the Clean Water Act most relevant to Integrated Farm Drainage Management (IFDM) projects may include:

Section 404, Clean Water Act: *Waters of the United States are divided into "wetlands" and "other waters of the United States." Wetlands are defined as "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions"* (33 Code of Federal Regulations [CFR] 328.3[b], 40 CFR 230.3). Jurisdictional wetlands must support positive indicators for hydrophytic vegetation, hydric soil, and wetland hydrology. Other waters of the United States are defined as those that lack positive indicators for one or more of the three wetland parameters identified above and include seasonal or perennial water bodies, including lakes, stream channels, drainages, ponds, and other surface water features, that exhibit an ordinary high-water mark (33 CFR 328.4).

Section 402, Clean Water Act:

Common pollutants that are subject to NPDES permit limitations are biological waste, toxic chemicals, oil and grease, metals, and pesticides. NPDES permitting is administered by the Regional Water Quality Control Board (RWQB) under the authority of the State Water Resources Control Board (SWRCB).

Resource Conservation and Recovery Act (RCRA): In California, RCRA is enforced by local Certified Unified Program Agencies (CUPAs) and the Department of Toxic Substances Control (DTSC). When it was enacted in 1976, it introduced the concept of "cradle to grave" management of hazardous waste as well as use of the Uniform Hazardous Waste Manifest. Under RCRA, in order for a substance to be considered a hazardous waste, it must first be a waste (i.e., you are done using it and/or it is inherently "waste-like"). Secondly, the waste must either (1) be on a list of wastes that are automatically considered to be hazardous; or (2) display characteristics that make it a hazardous waste (i.e., toxicity, ignitability, reactivity or corrosivity).

If the waste is hazardous under RCRA, the generator must file a notification with EPA and obtain a hazardous waste generator identification number, comply with requirements for appropriate storage of the material prior to shipment, ship the material under a Uniform Hazardous Waste Manifest using a hauler licensed to transport hazardous waste, and dispose of the material at a specially licensed treatment or disposal site. Selenium and selenium compounds are considered Acutely Hazardous Wastes under RCRA. If the amount of Acutely Hazardous Waste generated exceeds 1 kilogram (kg) in any given month, then the generator is responsible to comply with additional reporting, training, storage and waste minimization requirements.

Finally, the generator is responsible for the waste even after it is deposited in a disposal facility. This means that the generator could ultimately be responsible to contribute funds to clean up of the disposal facility, if that were to be required in the future. Of note is the fact that if a hazardous waste is recyclable, it is subject to RCRA storage and handling requirements, but there is no long-term liability. If the salt residue were a commercial product and not a waste, it would not be subject to RCRA requirements.

Hazardous Waste Control Law (HWCL) is codified in the Health & Safety Code Division 20, Chapter 6.5 and implementing regulations found in California Code of Regulations, Title 22, Division 4.5. The requirements of the HWCL are enforced by the local CUPA and/or DTSC.

Hazardous Waste Control Law (HWCL) California defines characteristic hazardous wastes based on either (or both) the soluble or total concentration of a hazardous constituent.

For selenium, this is defined as a Soluble Threshold Limit Concentration (STLC) of 1.0 mg/L as determined by the California Waste Extraction Test or a Total Threshold Limit Concentration of 100 mg/kg. Hazardous waste generated in California is subject to additional reporting requirements and a hazardous waste generator tax levied by the state Board of Equalization. Any treatment of hazardous waste at a site to change its characteristics or render it less toxic is subject to additional regulatory and permitting requirements.

Section 404, Clean Water Act: Certain ongoing, normal farming practices in wetlands are exempt and do not require a permit. This includes, among other things, maintenance (but not construction or alteration of) drainage ditches, construction and maintenance of irrigation ditches, and construction and maintenance of farm or stock ponds. In order to be exempt, the activities cannot be associated with converting an agricultural wetland into a non-wetland or bringing a wetland into agricultural production. Other requirements define and regulate "Prior Converted Cropland" and "Farmed Wetlands."

Federal Endangered Species Act (FESA): Actions that lead to take can result in civil or criminal penalties. Authorization for "take" must be received from the appropriate federal regulatory agency (USFWS, NOAA Fisheries, etc.), if compliance with standard avoidance measures are not feasible. Section 10 outlines the process by which entities may obtain a permit for the "incidental take" of a listed species.

Under Section 7 a federal lead agency must consult with relevant federal regulatory agencies to ensure that the actions of a project do not jeopardize the continued existence of listed species. If the project has the potential to affect listed species, a federal lead agency must prepare a Biological Assessment (BA) identifying the project effects and submit it to other federal agencies for review. The reviewing federal agencies would make a determination regarding effects and proposed mitigation measures and, after consultation, issues a Biological Opinion (BO) that may authorize "take" but could lead to changes in avoidance and mitigation measures and may require modification of the project design.

If the project affects species listed jointly under the federal and state Endangered Species Acts, DFG typically participates in Section 7 consultation to the greatest extent possible. The federal BO generally reflects both state and federal findings, and DFG is encouraged in the state Endangered Species Act to adopt, when possible, the USFWS biological opinion as its own formal written determination on whether jeopardy to endangered species exists. If, however, USFWS and DFG ultimately fail to agree, the agencies may issue independent biological opinions.

California Endangered Species Act (CESA): Section 2080 of the Fish and Game Code prohibits "take" of any species that the Fish and Game Commission determines to be an endangered species or threatened species. Take is defined in Section 86 of the Fish and Game Code as *"hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill."* CESA allows for take incidental to otherwise lawful development projects but emphasizes early consultation to avoid potential impacts to rare, endangered, and threatened species and to develop appropriate mitigation planning. Mitigation planning is intended to offset project caused losses of listed species populations and their essential habitats.

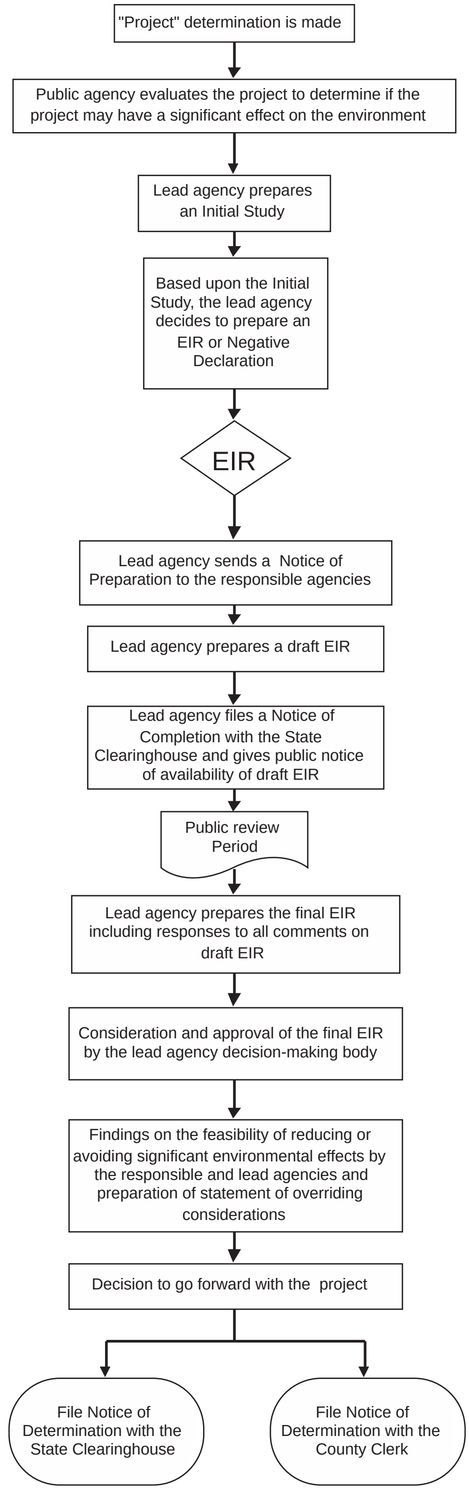
Sections 2081(b) and (c) of the California Endangered Species Act allow the Department to issue an incidental take permit for a State listed threatened and endangered species only if specific criteria are met. Title 14 California Code of Regulations (CCR), Sections 783.4(a) and (b) summarizes the criteria as: *"The authorized take **is** incidental to an otherwise lawful activity; The impacts of the authorized take are minimized and fully mitigated; The measures required to minimize and fully mitigate the impacts of the authorized take are roughly proportional in extent to the impact of the taking on the species, maintain the applicant's objectives to the greatest extent possible, and are capable of successful implementation; Adequate funding is provided to implement the required minimization and mitigation measures and to monitor compliance with and the effectiveness of the measures; and Issuance of the permit will not jeopardize the continued existence of a State-listed species."*

Fish and Game Code outlines the authority DFG has to protect and conserve natural resources within the state. The code has provisions for DFG authority under the CESA including regulatory authority for activities in channels, beds, and banks of lakes, rivers and streams.

Fully Protected Animals: Table 1 provides a complete list of animals with Fully Protected status.

Figure 1. CEQA Process.

Overview of the CEQA process



Adapted from CERES CEQA process flow chart

Appendix

Table 1. Fully Protected Animals.

COMMON NAME	SCIENTIFIC NAME
Fishes	
Colorado River squawfish (=Colorado pikeminnow)	*Ptychocheilus lucius*
thicktail chub	*Gila crassicauda*
Mohave chub (=Mohave tui chub)	*Gila mohavensis*
Lost River sucker	*Catostomus luxatus* (=*Deltistes luxatus*)
Modoc sucker	*Catostomus microps*
shortnose sucker	*Chasmistes brevirostris*
humpback sucker (=razorback sucker)	*Xyrauchen texanus*
Owens River pupfish (=Owens pupfish)	*Cyprinoden radiosus*
unarmored threespine stickleback	*Gasterosteus aculeatus williamsoni*
rough sculpin	*Cottus asperrimus*
Amphibians	
Santa Cruz long-toed salamander	*Ambystoma macrodactylum croceum*
limestone salamander	*Hydromantes brunus*
black toad	*Bufo exsul*
Reptiles	
blunt-nosed leopard lizard	*Gambelia sila* (=*Gambelia silus*)
San Francisco garter snake	*Thamnophis sirtalis tetrataenia*
Birds	
American peregrine falcon	*Falco peregrinus anatum*
brown pelican (=California brown pelican)	*Pelecanus occidentalis* (=*P. o. occidentalis*)
California black rail	*Laterallus jamaicensis coturniculus*
California clapper rail	*Rallus longirostris obsoletus*
California condor	*Gymnogyps califonianus*
California least tem	*Sterna albifrons browni* (=*Sterna antillarum browni*)
golden eagle	*Aquila chrysaetos*
greater sandhill crane	*Grus candadensis tabida*
light-footed clapper rail	*Rallus longirostris levipes*
southern bald eagle (=bald eagle)	*Haliaeetus leucocephalus leucocephalus* (=*Haliaeetus leucocephalus*)
trumpeter swan	*Cygnus buccinator*
white-tailed kite	*Elanus leucurus*
Yuma clapper rail	*Rallus longirostris yumanensis*
Mammals	
Morro Bay kangaroo rat	*Dipodomys heermanni morroensis*
bighorn sheep	*Ovis canadensis* - except Nelson bighorn sheep (*ssp. Ovis canadensis nelsoni*) in the area described in subdivision (b) of Section 4902 (Fish and Game Code)
northern elephant seal	*Mirounga angustirostris*
Guadalupe fur seal	*Arctocephalus townsendi*
ring-tailed cat	*Genus Bassariscus* (=*Bassariscus astutus*)
Pacific right whale	*Eubalanea sieboldi* (=*Balaena glacialis*)
salt-marsh harvest mouse	*Reithrodontomys raviventris*
southern sea otter	*Enhydra lutris nereis*
wolverine	*Gulo luscus* (=*Gulo gulo*)

Chapter Authors and Biographies

Chapter 1

Liz Hudson

Liz Hudson, APR, is a principal in Hudson•Orth Communications, a public relations firm specializing in agriculture and water communications. Hudson has more than 25 years experience in agricultural and water communications. She has a degree in agricultural journalism from California Polytechnic State University, San Luis Obispo, and holds a national accreditation in public relations from the Public Relations Society of America.

Chapter 2

Tim Jacobsen

Tim Jacobsen is an education specialist for the Center for Irrigation Technology at California State University, Fresno. He has worked in the area of agricultural irrigation for 20 years and now teaches on agricultural topics throughout California.

Lisa Basinal

Lisa Basinal is an Education Specialist for the Center for Irrigation Technology at California State University, Fresno. She has worked in the areas of plant genetics, post-harvest, and agricultural pumping and irrigation for the past six years and now teaches on agricultural topics throughout California.

Nettie R. Drake

Nettie R. Drake is a watershed specialist with MFG, Inc., an environmental engineering and scientific consulting firm. She has an extensive background in agricultural production and has been involved with watershed and resource management on the Westside of the San Joaquin Valley for the past eight years. As part of the watershed management, she has been very involved with the drainage issues and the evolution of the IFDM systems.

Vashek Cervinka, Ph.D.

Dr. Vashek Cervinka is an agricultural engineer specializing in agricultural drainage issues and renewable energy. He earned a doctorate from the University of California, Davis, and has 35 years of experience in agriculture with the California Department of Food and Agriculture, the California Department of Water Resources, and Westside Resource Conservation District. For the last 19 years he has worked extensively with IFDM.

Kathleen Buchnoff

Kathleen Buchnoff is an engineer in the California Department of Water Resources' Integrated Drainage Management Section, a part of the Agricultural Drainage Program. That program's goal is to control subsurface drainage water, salt, selenium, boron and other toxic elements to maintain agricultural productivity on irrigated farmland with salinity problems. Buchnoff also provides technical assistance in the areas of drainage management, concentration and removal of salts from drainage water through various technologies, utilization of drainage salts and related areas. She also assists in coordinating the monitoring activities for IDM projects.

Morris A. "Red" Martin

Morris A. "Red" Martin has been a Westside fixture for nearly 50 years. His career includes serving as a Soil Conservationist with the U.S. Department of Agriculture's Soil Conservation Service, now called Natural Resources Conservation Service. Martin is a recognized expert in soil and water conservation and a pioneer in the area of IFDM development and implementation. Martin also serves as a guest lecturer at California State University, Fresno, where he received a degree in agriculture. He also served as the Executive Director of the Westside Resource Conservation District.

Chapter 3

Kathleen Buchnoff

Kathleen Buchnoff is an engineer in the California Department of Water Resources' Integrated Drainage Management Section, a part of the Agricultural Drainage Program. That program's goal is to control subsurface drainage water, salt, selenium, boron and other toxic elements to maintain agricultural productivity on irrigated farmland with salinity problems.

Buchnoff also provides technical assistance in the areas of drainage management, concentration and removal of salts from drainage water through various technologies, utilization of drainage salts and related areas. She also assists in coordinating the monitoring activities for IDM projects.

Julie Vance

Julie Vance is an Environmental Scientist with the California Department of Water Resources, San Joaquin District. Vance has been involved with drainage issues for six years. Her areas of expertise include agricultural drainage-related impacts to avian species, aquatic ecology, aquatic invertebrates, amphibian ecology, special status species of the San Joaquin Valley and environmental permitting and compliance.

Lisa Basinal

Lisa Basinal is an Education Specialist for the Center for Irrigation Technology at California State University, Fresno. She has worked in the areas of plant genetics, post-harvest, and agricultural pumping and irrigation for the past six years and now teaches on agricultural topics throughout California.

Chapter 4

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Chapter 5

Sharon E. Benes, Ph.D.

Dr. Sharon E. Benes received her doctorate in plant physiology from the University of California, Davis. She now serves as an Assistant Professor in the Department of Plant Science at California State University, Fresno, where she teaches undergraduate and graduate courses in soils and plant nutrition. Benes' area of research specialty includes examining the response of plants to salinity and soil and water management under saline conditions. Since 1977 she has conducted long-term field evaluations of salt-tolerant forages and halophytes for drainage water reuse systems for the Westside of the San Joaquin Valley.

Tim Jacobsen

Tim Jacobsen is an education specialist for the Center for Irrigation Technology at California State University, Fresno. He has worked in the area of agricultural irrigation for 20 years and now teaches on agricultural topics throughout California.

Lisa Basinal

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Chapter 6

Sharon E. Benes, Ph.D.

Dr. Sharon E. Benes received her doctorate in plant physiology from the University of California, Davis. She now serves as an Assistant Professor in the Department of Plant Science at California State University, Fresno, where she teaches undergraduate and graduate courses in soils and plant nutrition. Benes' area of research specialty includes examining the response of plants to salinity and soil and water management under saline conditions. Since 1977 she has conducted long-term field evaluations of salt-tolerant forages and halophytes for drainage water reuse systems for the Westside of the San Joaquin Valley.

Stephen R. Grattan, Ph.D.

Dr. Stephen R. Grattan is a Plant-Water Relations Specialist for the University of California, Davis. Grattan has worked for more than 20 years on crop responses to saline conditions. Grattan's areas of expertise include irrigation management with saline water, plant response in saline environments; uptake of nutrients and trace elements by plants in saline environments; and crop water use.

Clarence Finch

Clarence Finch is retired from the U.S. Department of Agriculture's Natural Resources Conservation Service and currently works in a volunteer capacity for that agency. In his 35 years with the NRCS, he specialized in the area of vegetation establishment for the purpose of erosion control.

Lisa Basinal

Lisa Basinal is an Education Specialist for the Center for Irrigation Technology at California State University, Fresno. She has worked in the areas of plant genetics, post-harvest, and agricultural pumping and irrigation for the past six years and now teaches on agricultural topics throughout California.

Chapter 7

Lisa Basinal

Lisa Basinal is an Education Specialist for the Center for Irrigation Technology at California State University, Fresno. She has worked in the areas of plant genetics, post-harvest, and agricultural pumping and irrigation for the past six years and now teaches on agricultural topics throughout California.

Andrew G. Gordus, Ph.D.

Dr. Andrew G. Gordus is a Senior Environmental Scientist (Supervisor) with the California Department of Fish and Game and has been involved in irrigation and drainage management issues for more than 10 years. He received his doctorate in comparative pathology from the University of California, Davis. Dr. Gordus's areas of expertise include wildlife disease and toxicology; waterfowl and shorebird management; wetland and upland habitat management; and environmental regulations.

Chapter 8

Tim Jacobsen

Tim Jacobsen is an education specialist for the Center for Irrigation Technology at California State University, Fresno. He has worked in the area of agricultural irrigation for 20 years and now teaches on agricultural topics throughout California.

Nettie R. Drake

Nettie R. Drake is a watershed specialist with MFG, Inc., an environmental engineering and scientific consulting firm. She has an extensive background in agricultural production and has been involved with watershed and resource management on the Westside of the San Joaquin Valley for the past eight years. As part of the watershed management, she has been very involved with the drainage issues and the evolution of the IFDM systems.

Chapter 9

Gerald Hatler

Gerald Hatler is an Environmental Scientist with the California Department of Water Resources where he conducts fish and wildlife resource evaluation, environmental documentation and project review. He has been involved with natural resource evaluation, management and research for seven years. Prior to his current position, Hatler worked for the California Department of Fish and Game managing, developing and participating in research programs; evaluations of fish, wildlife and botanical resources with an emphasis on riparian habitat restoration; geomorphology; anadromous fisheries; big game population assessment; and telemetry studies.

Wayne Verrill

Wayne Verrill works as an Environmental Scientist with the State Water Resources Control Board. He is a soil scientist by training with previous experience in environmental consulting. Verrill has worked for the State of California for eight years primarily on utilization and disposal of agricultural drainage.

Mike Tietze, C.HG, C.E.G.

Michael Tietze is a Senior Consulting Hydrogeologist with MFG, Inc., a Tetra Tech company, and he currently manages the company's California operations. Tietze has 20 years experience working with industrial, agricultural, timber, commercial and municipal clients and law firms investigating the presence of and behavior of toxic substances in the environment. He has also worked on assessing compliance with environmental regulations and developing clean-up strategies.

REVISED
July 07, 2003

Appendix Item 7
STATE WATER RESOURCES CONTROL BOARD
BOARD MEETING SESSION--DIVISION OF WATER QUALITY
JULY 16, 2003

ITEM 9

SUBJECT

CONSIDERATION OF A RESOLUTION ADOPTING EMERGENCY REGULATIONS THAT ESTABLISH MINIMUM REQUIREMENTS FOR THE DESIGN, CONSTRUCTION, OPERATION, AND CLOSURE OF SOLAR EVAPORATORS AS COMPONENTS OF INTEGRATED ON-FARM DRAINAGE MANAGEMENT SYSTEMS

DISCUSSION

In 1990, the San Joaquin Valley Drainage Program recommended the implementation of sequential agricultural drainage reuse systems, now known as Integrated on-Farm Drainage Management (IFDM) systems, as one major component of a comprehensive agricultural drainage management plan to address the impact of poor quality shallow groundwater on now almost one million acres of agricultural land on the westside of the San Joaquin Valley. The plan recommended that 156,000 acres of tile-drained cropland be included in drainage reuse or IFDM systems by the year 2000 in the initial phase of the proposed 50-year plan to manage shallow groundwater and salinity in-valley and sustain productivity of agricultural lands. The recommendation was contained in *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley*, popularly known as the Rainbow Report. In 1991, the State Water Resources Control Board (SWRCB) entered into a Memorandum of Understanding with seven other State and federal agencies to form the San Joaquin Valley Drainage Implementation Program (SJVDIP) for the purpose of implementing the recommendations of the Rainbow Report.

There are two types of evaporation systems currently used by farmers in the San Joaquin Valley to manage agricultural drainage water. The first are the large evaporation ponds in Tulare Lake Basin that receive and store drainage water directly from irrigated farmland without reuse. The second are the solar evaporators operated as part of an IFDM system. Agricultural drainage water is sequentially reused (one to three times) to irrigate salt-tolerant forage and other crops until the volume of drainage water is substantially decreased and its salt content significantly increased. The concentrated brine is then sprayed into an on-farm solar evaporator—a shallow basin that is the endpoint of the sequential reuse system. No off-farm discharge of drainage water occurs in this system. It has been proposed that crystallized salts from the solar evaporator be harvested as a commercial product; however, no markets have yet been established.

The first drainage reuse pilot project was initiated on a site near Mendota by the Westside Resource Conservation District in 1985, with the support of several State and federal government agencies. In 1994, work began on the development of a complete IFDM system for sequential drainage reuse at Red Rock Ranch in western Fresno County. Development of IFDM systems and solar evaporators has focused for the last nine years on Red Rock Ranch. The Red Rock Ranch prototype IFDM system has achieved significant improvements in root zone soil and water quality and crop productivity on about 76% of the farmed acreage, with substantial improvement in the productivity of high-value salt-sensitive crops. Productive reuse has been made of the drainage water collected on-farm for irrigating salt-tolerant forage, cotton, and other crops on another 23% of the IFDM system acreage.

A small solar evaporator was constructed as the salt end-point component of this IFDM system. Waste Discharge Requirements (WDR) for its operation were established by the Central Valley Regional Water Quality Control Board (CVRWQCB). However, naturally high selenium concentrations in the drainage discharged to the evaporator invoked regulatory provisions of the Toxic Pits Cleanup Act (TPCA 1984) and created difficulties in permitting the solar evaporator as the essential final component of the IFDM system. Red Rock Ranch experienced difficulty in efficiently operating the solar evaporator while meeting the WDR's and was served with Notices of Violation. Problems were associated with ponding sufficient to develop a growth of invertebrates (primarily brine flies) initiating a selenium-containing food chain that resulted in impacts to nesting shorebirds. The data for stilts nesting near the solar ~~pond~~ evaporator at Red Rock Ranch represent the highest percent incidence of selenium-induced birth defects reported from field studies to date. These and other problems resulted in the cessation of operation of the original solar evaporator at the Ranch. Attempted solutions to resolve the conflict with TPCA were found to be impractical and infeasible.

Meanwhile, rising water tables and increasing soil salinity threaten root zone soil and water quality and continued productivity on westside San Joaquin Valley agricultural lands. To date, complete IFDM systems have been developed on only about 1600 acres of agricultural land. At the present time, other alternatives for the management of subsurface agricultural drainage, such as out-of-valley disposal of drainage to the Bay-Delta or Pacific Ocean, or discharge to large, conventional evaporation ponds, is either generally unavailable or infeasible. A number of growers on the westside of the San Joaquin Valley would like to institute complete IFDM systems with solar evaporators and resulting improvements in soil and water quality, but are reluctant to do so until the existing regulatory issues with respect to the Red Rock Ranch solar evaporator are resolved. Further, other growers and districts are instituting partial IFDM systems with salt-tolerant crop reuse components but with no solar evaporators as a salt endpoint. Incomplete IFDM systems without salt endpoints risk future loss of soil and water quality improvements, and impacts to wildlife.

This situation has placed the entire operation of IFDM systems and the future implementation of the Rainbow Report recommendations in question and led to the passage of Senate Bill (SB) 1372 in September, 2002. By this act, solar evaporators are exempt from the provisions of TPCA. Solar evaporators did not exist at the time of enactment of TPCA, and the provisions of TPCA do not take account of the unique circumstances and conditions pertinent to solar evaporators. SB 1372 also exempts solar evaporators from WDRs under the California Water Code, and requires the development of new emergency regulations specifically designed to address the environmental and operational conditions associated with solar evaporators, thereby facilitating the full development and completion of IFDM systems.

The new regulations establish minimum requirements for the design, construction, operation, and closure of solar evaporators and have been developed through a review of existing information on the development and regulation of solar evaporators, and through informal consultation with other State agencies, primarily the Department of Water Resources, and the Department of Food and Agriculture. Technical advice and recommendations were requested of the Department of Fish and Game and the U.S. Fish and Wildlife Service, as required by SB 1372. A fact finding field tour of existing and proposed solar evaporators was made in December, 2002, with meetings held with existing operators and prospective applicants. The tour included an innovative new solar evaporator design currently being developed and tested at Red Rock Ranch.

The new regulations closely follow the language and intent of SB 1372, adding clarity and specificity where needed or useful. Existing regulations in the California Code of Regulations are cited or referenced where appropriate. The new regulations are primarily designed to account for the no standing water provision of SB 1372. A specific definition of “standing water” has been developed based on limiting the potential for growth of brine flies that could result in biomagnification of selenium in a food chain. The “standing water” definition is thereby designed to provide adequate wildlife protection. Another important definition is “reasonably foreseeable operating conditions” that has been specified for both the design capacity of solar evaporator operating systems and natural occurrence of floods and incident rainfall. The definition of “water catchment basin” has been expanded to include a solar still or greenhouse as a fully contained component for the final separation and desiccation of salt. The new design and operation standards are intended to facilitate the development and implementation of solar evaporators as components of IFDM systems, while protecting avian wildlife and existing groundwater quality.

Adoption by the SWRCB of new solar evaporator emergency regulations has been determined by the Office of the Chief Counsel to be subject to an emergency exemption from the California Environmental Quality Act.

POLICY ISSUE

Should the SWRCB adopt emergency regulations (see attachment) that establish minimum requirements for the design, construction, operation, and closure of solar evaporators as components of IFDM systems in compliance with SB 1372?

FISCAL IMPACT

Annual costs of approximately $181,000 are anticipated for the (CVRWQCB) in FY 2003-2004, and $161,000 annually thereafter, to carry out the provisions of the new solar evaporator regulations. SB 1372 requires any Regional Water Quality Control Boards (RWQCBs) receiving a Notice of Intent to construct and operate a solar evaporator to review the application, inspect the site, identify additional data requirements, conduct facility inspections after construction, determine facility compliance with the requirements of the regulations, review annual monitoring data reports, and other tasks. Although the bill prohibits RWQCBs from approving new facilities after January 1, 2008, operation of facilities approved prior to that date would be allowed to continue and, therefore, would require continued regulatory effort by the RWQCBs. Funds from the existing Surface Impoundment Assessment Account in the General Fund (approximately $1.2 million) may be used for this purpose.

RWQCB IMPACT

Yes, mainly Central Valley Regional Water Quality Control Board.

STAFF RECOMMENDATION

Staff recommends adoption of emergency regulations that establish minimum requirements (see attachment) for the design, construction, operation, and closure of solar evaporators as components of IFDM systems in compliance with SB 1372.

STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 2003-

AUTHORIZING A RESOLUTION ADOPTING EMERGENCY REGULATIONS THAT ESTABLISH MINIMUM REQUIREMENTS FOR THE DESIGN, CONSTRUCTION, OPERATION, AND CLOSURE OF SOLAR EVAPORATORS AS COMPONENTS OF INTEGRATED ON-FARM DRAINAGE MANAGEMENT (IFDM) SYSTEMS

WHEREAS:

1. The sustainability of approximately one million acres of productive agricultural land on the westside of the San Joaquin Valley is threatened by rising shallow groundwater of poor quality.

2. Recommended measures contained in *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley*, to provide short-term agricultural drainage relief, include sequential drainage reuse or IFDM systems.

3. IFDM systems require an evaporation system as the final component for the separation and collection of salt.

4. The Legislature has found that IFDM is a sustainable system of managing salt-laden farm drainage water. IFDM is designed to eliminate the need for off-farm drainage of irrigation water, prevent the on-farm movement of irrigation and drainage water to groundwater, restore and enhance the productive value of degraded farmland by removing salt and selenium from the soil, conserve water by reducing the demand for irrigation water, and create the potential to convert salt from a waste product and pollutant to a commercial farm commodity.

5. The Legislature has found it is the policy of the state to conserve water and to minimize the environmental impacts of agricultural drainage. It is therefore in the interests of the state to encourage the voluntary implementation of sustainable farming and irrigation practices, including, but not limited to, IFDM as a means of improving environmental protection, conserving water, restoring degraded soils, and enhancing the economic productivity of farms.

6. The Legislature has directed the State Water Resources Control Board (SWRCB), on or before April 1, 2003, to adopt emergency regulations that establish minimum requirements for the design, construction, operation, and closure of solar evaporators. The SWRCB granted a delay in adoption as requested by other State agencies and stakeholders.

7. This action to adopt emergency solar evaporator regulations is exempt from the requirements of the California Environmental Quality Act pursuant to Public Resources Code section 21080(b)(4).

8. The SWRCB has developed new solar evaporator regulations in compliance with Senate Bill 1372 (SB 1372) to be located within California Code of Regulations Title 27, that facilitate the development and implementation of solar evaporators as components of IFDM systems, while protecting avian wildlife safety and groundwater quality.

THEREFORE BE IT RESOLVED THAT:

The State Water Resources Control Board adopts emergency regulations (see attachment) that establish minimum requirements for the design, construction, operation, and closure of solar evaporators as components of IFDM systems in compliance with SB 1372.

CERTIFICATION

The undersigned, Clerk to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on July 16, 2003.

____
Debbie Irvin
Clerk to the Board

Title 27. Environmental Protection

Division 2. Solid Waste

Subdivision 1. Consolidated Regulations for Treatment, Storage, Processing, or Disposal of Solid Waste

Chapter 7. Special Treatment, Storage, and Disposal Units

Subchapter 6. Solar Evaporators

Article 1. Solar Evaporator Regulations

[Note: regulations in this article were promulgated by the State Water Resources Control Board (SWRCB), are administered by the appropriate Regional Water Quality Control Board (RWQCB), and are applicable to the owner or operator of a solar evaporator for the management of agricultural drainage water discharges from an integrated on-farm drainage management system (IFDM).]

§22900. SWRCB – Applicability.

(a) General—This article applies to the discharge of agricultural drainage water from Integrated On-Farm Drainage Management (IFDM) systems to solar evaporators as defined in §22910. No SWRCB-promulgated parts of the Division 2 of Title 27 and Division 3, Chapter 15 of Title 23 of the California Code of Regulations (CCR) shall apply to the discharge of agricultural drainage water from IFDM systems to solar evaporators unless those sections are specifically referenced in this article. Any person who intends to operate a solar evaporator after ~~July 1, 2003~~ [effective date] shall comply with the requirements of this article before a Notice of Plan Compliance and Notice of Authority to Operate (§25209.13 of Article 9.7 of the Health and Safety Code) will be issued by a Regional Water Quality Control Board (RWQCB).

§22910. SWRCB – Definitions.

For purposes of this article, the following terms have the following meanings:

(a) “Adequately protected” means that:
(1) Avian wildlife have no access to standing water in a water catchment basin.
(2) Standing water does not occur in a solar evaporator outside of a water catchment basin, under reasonably forseeable operating conditions.

(3) The solar evaporator, including the water catchment basin, does not become a medium for the growth of ~~aerial~~ aquatic and semi-aquatic macro invertebrates that could become a harmful food | source for avian wildlife, under reasonably forseeable operating conditions.

(b) "Agricultural drainage water" means surface drainage water or percolated irrigation water that is collected by subsurface drainage tiles placed beneath an agricultural field.

(c) “Avian Wildlife Biologist” means any State or federal agency biologist, ecologist, environmentalspecialist (or equivalent title) with relevant avian wildlife monitoring experience (as determined by the RWQCB), or any professional biologist, ecologist, environmental specialist (or equivalent title) possessing valid unexpired State and federal collecting permits for avian wildlife eggs.

(d) <u>“Boundaries of the solar evaporator” or “boundaries of a solar evaporator” means the outer edge of the solar evaporator or any component of the solar evaporator, including, but not limited to, berms, liners, water catchment basins, windscreens, and deflectors.</u> |

(~~d~~<u>e</u>) “Certified Engineering Geologist” means a registered geologist, certified by the State of California, pursuant to section 7842 of the Business and Professions Code. |

(~~e~~<u>f</u>) “Hydraulic conductivity” means the ability of natural and artificial materials to transmit water. The term is expressed as a measure of the rate of flow through a unit area cross-section of material. The unit of measure is cm/sec. |

(~~f~~<u>g</u>) "Integrated on-farm drainage management system" means a facility for the on-farm management of agricultural drainage water that does all of the following: |
(1) Reduces levels of salt and selenium in soil by the application of irrigation water to agricultural fields.
(2) Collects agricultural drainage water from irrigated fields and sequentially reuses that water to irrigate successive crops until the volume of residual agricultural drainage water is substantially decreased and its salt content significantly increased.
(3) Discharges the residual agricultural drainage water to an on-farm solar evaporator for evaporation and appropriate salt management.
(4) Eliminates discharge of agricultural drainage water outside the boundaries of the property or properties that produces the agricultural drainage water and that is served by the integrated on-farm drainage management system and the solar evaporator.

(~~g~~<u>h</u>) “Liner” means: |
(1) a continuous layer of natural or artificial material, or a continuous membrane of flexible and durable artificial material, or a continuous composite layer consisting of a membrane of flexible artificial material directly overlying a layer of engineered natural material, which is installed beneath a solar evaporator, and which acts as a barrier to vertical water movement, and
(2) a material that has appropriate chemical and physical properties to ensure that the liner does not fail to contain agricultural drainage water because of pressure gradients, physical contact with the agricultural drainage water, chemical reactions with soil, climatic conditions, ultraviolet radiation (if uncovered), the stress of installation, and the stress of daily operation, and

(3) a material that has a minimum thickness of 40 mils (0.040 inches) for flexible artificial membranes or synthetic liners.
(4) The requirements of this definition are applicable only if a liner is used to meet the requirements of §22920(c).

(~~h~~i) “Nuisance” means anything which meets all of the following requirements:
(1) Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property.
(2) Affects at the same time an entire community or neighborhood, or a considerable number of persons, although the extent of the annoyance or damage inflicted on individuals may be unequal.
(3) Occurs during, or as a result of, the treatment or disposal of wastes.

(~~i~~j) "On-farm" means within the boundaries of a property, geographically contiguous properties, or a portion of the property or properties, owned or under the control of a single owner or operator, that is used for the commercial production of agricultural commodities and that contains an IFDM system and a solar evaporator.

(~~j~~k).”Pollution” means an alteration of the quality of the waters of the state by waste to a degreewhich unreasonably affects either of the following:
(1) The waters for beneficial uses.
(2) Facilities which serve these beneficial uses.

(~~k~~l) “Reasonably foreseeable operating conditions” means:
(1) within the range of the design discharge capacity of the IFDM system and the authorized solar evaporator system as specified in the Notice of Plan Compliance and Notice of Authority to Operate (§25209.13 of Article 9.7 of the Health and Safety Code),
(2) precipitation up to and including the local 25-year, 24-hour storm, and
(3) floods with a 100-year return period.
Operation of a solar evaporator in exceedance of design specifications is not covered by “reasonably foreseeable operating conditions,” and therefore would constitute a violation of the Notice of Authority to Operate.

(~~l~~m) “Regional Board” and “RWQCB” means a California Regional Water Quality Control Board.

(~~m~~n) “Registered Agricultural Engineer” means an agricultural engineer registered by the State of | California, pursuant to section 6732 of the Business and Professions Code.

(~~n~~o) “Registered Civil Engineer” means a civil engineer registered by the State of California, pursuant to section 6762 of the Business and Professions Code.

(~~o~~p) “Registered Geologist” means a geologist registered by the State of California, pursuant to section 7842 of the Business and Professions Code.

(~~p~~q) "Solar evaporator" means an on-farm area of land and its associated equipment that meets all of the following conditions:

(1) It is designed and operated to manage agricultural drainage water discharged from the IFDM system.
(2) The area of the land that makes up the solar evaporator is equal to, or less than, 2 percent of the area of the land that is managed by the IFDM system.
(3) Agricultural drainage water from the IFDM system is discharged to the solar evaporator by timed sprinklers or other equipment that allows the discharge rate to be set and adjusted as necessary to avoid standing water within the solar evaporator or, if a water catchment basin is part of the solar evaporator, within that portion of the solar evaporator that is outside the basin.
(4) The combination of the rate of discharge of agricultural drainage water to the solar evaporator and subsurface tile drainage under the solar evaporator provides adequate assurance that constituents in the agricultural drainage water will not migrate from the solar evaporator into the vadose zone or waters of the state in concentrations that pollute or threaten to pollute the waters of the state.

(~~q~~r) "Standing water" means water occurring under all of the following conditions:
(1) to a depth greater than one centimeter,
(2) for a continuous duration in excess of 48 hours,
(3) as a body of any areal extent, not an average depth, and
(4) under reasonably forseeable operating conditions.

(~~r~~s) "Subsurface drainage tiles" or "subsurface tile drainage" means any system of subsurface drainage collection utilizing drainage tiles, perforated pipe, or comparable conveyance, placed below the surface of any IFDM system area including the solar evaporator.

(~~s~~t) "Unreasonable threat" to avian wildlife means that avian wildlife is not adequately protected.

(~~t~~u) "Vadose zone" means the unsaturated zone between the soil surface and the permanent groundwater table.

(~~u~~v) "Water catchment basin" means an area within the boundaries of a solar evaporator that is designated to receive and hold any water that might otherwise be standing water within the solar evaporator. The entire area of a water catchment basin shall be permanently and continuously covered with netting, or otherwise designed, constructed, and operated to prevent access by avian wildlife to standing water within the basin. A water catchment basin may include an enclosed solar still, greenhouse or other fully contained drainage storage unit. For the purposes of this definition, the term "within the boundaries of a solar evaporator" shall include a solar still, greenhouse, or other fully contained drainage storage unit adjacent to or near the portion of the solar evaporator that is outside the catchment basin.

(~~u~~w) "Waters of the state" means any surface water or groundwater, including saline water, within the boundaries of the state.

§22920. SWRCB – Solar Evaporator Design Requirements.

(a) Registered Professionals—Solar evaporators shall be designed by a registered civil or agricultural engineer, or a registered geologist or certified engineering geologist.

(b) Flooding--A solar evaporator shall be located outside the 100-year floodplain, or shall be constructed with protective berms/levees sufficient to protect the solar evaporator from overflow and inundation by 100-year floodwaters, or shall be elevated above the maximum elevation of a 100-year flood.

(c) Protection of Groundwater Quality -- Solar evaporators shall be immediately underlain by at least 1 meter of soil with a hydraulic conductivity of not more than 1 x 10^{-6} cm/sec above the zone of shallow groundwater at any time during the year. The surface of the solar evaporator shall be a minimum of five-feet (5 ft.) above the highest anticipated elevation of underlying groundwater. A solar evaporator may be constructed on a site with soils that do not meet the above requirement, with subsurface tile drainage under or directly adjacent to the solar evaporator, a liner, or other engineered alternative, sufficient to provide assurance of the equivalent level of groundwater quality protection of the above soil requirement.

(d) Discharge to the Facility -- All discharge to the solar evaporator shall be agricultural drainage water collected from the IFDM system or recirculated from the solar evaporator as a component of the IFDM system. No agricultural drainage water from the IFDM system or the solar evaporator may be discharged outside the boundaries of ~~the area of land that makes up~~ the solar | evaporator

(e) Facility Size -- The area of land that makes up the solar evaporator may not exceed 2 percent of the area of land that is managed by the IFDM system.

(f) Means of Discharge to the Facility – Discharge of agricultural drainage water from the IFDM system to the solar evaporator shall be by timed sprinklers or other equipment that allows the discharge rate to be set and adjusted as necessary to avoid standing water in the solar evaporator, outside a water catchment basin. The sprinklers shall be equipped with screens or shields or other devices as necessary to prevent the drift of agricultural drainage water spray outside the boundaries of the solar evaporator.

(g) Water Catchment Basin -- A water catchment basin may be required:
(1) As a component of a solar evaporator if standing water would otherwise occur within the solar evaporator under reasonably foreseeable operating conditions, or
(2) If a solar evaporator is constructed with a liner. In this case, a water catchment basin shall be designed with the capacity to contain the maximum volume of water that the solar evaporator would collect under reasonably forseeable operating conditions. A water catchment basin is not required for a solar evaporator that does not have a liner, if it is demonstrated that standing water will not occur under reasonably foreseeable operating conditions.

(h) Avian Wildlife Protection -- The solar evaporator shall be designed to ensure that avian wildlife is adequately protected as set forth in §22910 (a) and (~~u~~v).

§22930. SWRCB – Solar Evaporator Construction Requirements.

(a) Registered Professionals—Construction of solar evaporators shall be supervised and certified, by a registered civil or agricultural engineer, or a registered geologist or certified engineering geologist, as built according to the design requirements and Notice of Plan Compliance (§25209.13 of Article 9.7 of the Health and Safety Code).

§22940. SWRCB – Solar Evaporator Operation Requirements.

(a) Limitation on Standing Water -- The solar evaporator shall be operated so that, under reasonably forseeable operating conditions, the discharge of agricultural drainage water to the solar evaporator will not result in standing water, outside of a water catchment basin. Agricultural drainage water from the IFDM system shall be discharged to the solar evaporator by timed sprinklers or other equipment that allows the discharge rate to be set and adjusted as necessary to avoid standing water in the solar evaporator.

(b) Prevention of Nuisance -- The solar evaporator shall be operated so that, under reasonably forseeable operating conditions, the discharge of agricultural drainage water to the solar evaporator does not result in:
(1) The drift of salt spray, mist, or particles outside of the boundaries of the solar evaporator, or
(2) Any other nuisance condition.

(c) Prohibition of Outside Discharge -- The operation of a solar evaporator shall not result in any discharge of agricultural drainage water outside the boundaries of ~~the area of land that makes up~~ the solar evaporator.

(d) Salt Management -- For solar evaporators in continuous operation under a Notice of Authority to Operate issued by a Regional Water Quality Control Board, evaporite salt accumulated in the solar evaporator shall be collected and removed from the solar evaporator if and when the accumulation is sufficient to interfere with the effectiveness of the operation standards of the solar evaporator as specified in this section. One of the following three requirements shall be selected and implemented by the owner or operator:
(1) Evaporite salt accumulated in the solar evaporator may be harvested and removed from the solar evaporator and sold or utilized for commercial, industrial, or other beneficial purposes.
(2) Evaporite salt accumulated in the solar evaporator may be stored for a period of one-year, renewable subject to an annual inspection, in a fully contained storage unit inaccessible to wind, water, and wildlife, until sold, utilized in a beneficial manner, or disposed in accordance with (3).
(3) Evaporite salt accumulated in the solar evaporator may be collected and removed from the solar evaporator, and disposed permanently as a waste in a facility authorized to accept such

waste in compliance with the requirements of Titles 22, 23, 27 and future amendments of the CCR, or Division 30 (commencing with Section 40000) of the Public Resources Code.

(e) Monitoring -- Monitoring and record keeping, including a groundwater monitoring schedule, data, and any other information or reporting necessary to ensure compliance with this article, shall be established by the RWQCB in accord with §25209.14 of Article 9.7 of the Health and Safety Code.

(f) Avian Wildlife Protection -- The solar evaporator shall be operated to ensure that avian wildlife is adequately protected as set forth in §22910 (a) and (~~u~~v). The following Best Management Practices are required:
(1) Solar evaporators (excluding water catchment basins) shall be kept free of all vegetation.
(2) Grit-sized gravel (<5 mm in diameter) shall not be used as a surface substrate within the solar evaporator.
(3) Netting or other physical barriers for excluding avian wildlife from water catchment basins shall not be allowed to sag into any standing water within the catchment basin.
(4) The emergence and dispersal of ~~aerial~~ aquatic and semi-aquatic macro invertebrates or aquatic plants outside of the boundary of the water catchment basin shall be prevented.
(5) The emergence of the pupae of ~~aerial~~ aquatic and semi-aquatic macro invertebrates from the water catchment basin onto the netting, for use as a pupation substrate, shall be prevented.

(g) Inspection – The RWQCB issuing a Notice of Authority to Operate a solar evaporator shall conduct authorized inspections in accord with §25209.15 of Article 9.7 of the Health and Safety Code to ensure continued compliance with the requirements of this article. The RWQCB shall request an avian wildlife biologist to assist the RWQCB in its inspection of each authorized solar evaporator at least once annually during the month of May. If an avian wildlife biologist is not available, the RWQCB shall nevertheless conduct the inspection. During the inspection, observations shall be made for compliance with §22910 (a) and (~~u~~v), and the following conditions that indicate an unreasonable threat to avian wildlife:
(1) Presence of vegetation within the ~~perimeter~~ boundaries of the solar evaporator;
(2) Standing water or other mediums within the solar evaporator that support the growth and dispersal of ~~aerial~~ aquatic or semi-aquatic macro invertebrates or aquatic plants;
(3) Abundant sustained avian presence within the solar evaporator that could result in nesting activity;
(4) An apparent avian die-off or disabling event within the solar evaporator;
(5) Presence of active avian nests with eggs within the ~~perimeter~~ boundaries of the solar evaporator.

If active avian nests with eggs are found within the ~~perimeter~~ boundaries of the solar evaporator, the RWQCB shall report the occurrence to the USFWS and DFG within 24 hours, and seek guidance with respect to applicable wildlife laws and implementing regulations. Upon observation of active avian nests with eggs within the ~~perimeter~~ boundaries of the solar evaporator, all discharge of agricultural drainage water to the solar evaporator shall cease until (a) the nests are no longer active, or (b) written notification is received by the owner or operator, from the RWQCB, waiving the prohibition of discharge in compliance with all applicable state and federal wildlife laws and implementing regulations (i.e., as per applicable exemptions and allowable take provisions of such laws and implementing regulations.)

§22950. SWRCB – Solar Evaporator Closure Requirements.

(a) For solar evaporators ceasing operation through discontinuance of operation or non-renewal of a Notice of Authority to Operate issued by a RWQCB, closure and post-closure plans shall be prepared and submitted to the RWQCB and approved by the RWQCB prior to closure. Closure plans shall conform to one of the following three requirements to be selected and implemented by the owner or operator:

(1) Evaporite salt accumulated in the solar evaporator may be harvested and removed from the solar evaporator and sold or utilized for commercial, industrial, or other beneficial purposes or stored for a period of one-year, renewable subject to an annual inspection, in a fully contained storage unit inaccessible to wind, water, and wildlife, until sold, utilized in a beneficial manner, or disposed in accordance with (3). After the removal of accumulated salt, the area within the boundaries of the solar evaporator shall be restored to a condition that does not pollute or threaten to pollute the waters of the state, that does not constitute an unreasonable threat to avian wildlife, and that does not constitute a nuisance condition. Clean closure may be accomplished in accord with §21090(f) and §21400 of CCR Title 27.

(2) The solar evaporator may be closed in-place, with installation of a final cover with foundation, low-hydraulic conductivity, and erosion-resistant layers, as specified in §21090 and §21400 of CCR Title 27. Closure in-place shall include a closure plan and post-closure cover maintenance plan in accord with §21090 and §21769 of CCR Title 27.

(3) Evaporite salt accumulated in the solar evaporator may be collected and removed from the solar evaporator, and disposed permanently as a waste in a facility authorized to accept such waste in compliance with the requirements of Titles 22, 23, 27 and future amendments of the CCR, or Division 30 (commencing with Section 40000) of the Public Resources Code. After the removal of accumulated salt, the area within the boundaries of the solar evaporator shall be restored to a condition that does not pollute or threaten to pollute the waters of the state, that does not constitute an unreasonable threat to avian wildlife, and that does not constitute a nuisance condition.

Senate Bill No. 1372

CHAPTER 597

An act to amend Section 25208.3 of, and to add Article 9.7 (commencing with Section 25209.10) to Chapter 6.5 of Division 20 of, the Health and Safety Code, relating to water.

[Approved by Governor September 15, 2002. Filed with Secretary of State September 16, 2002.]

LEGISLATIVE COUNSEL'S DIGEST

SB 1372, Machado. State Water Resources Control Board: agricultural drainage: solar evaporators.

(1) Under the Agricultural Water Conservation and Management Act, water suppliers, as defined, individually, or in cooperation with other public agencies or persons, may institute a water conservation or efficient water management program consisting of farm and agricultural related components. Existing law, the Toxic Pits Cleanup Act of 1984, prohibits a person from discharging liquid hazardous wastes into a surface impoundment if the surface impoundment, or the land immediately beneath the impoundment, contains hazardous wastes and is within $^1/_2$ mile upgradient from a potential source of drinking water.

This bill would require the State Water Resources Control Board to adopt, on or before April 1, 2003, emergency regulations that establish minimum requirements for the design, construction, operation, and closure of solar evaporators, as defined. The bill would require any person who intends to operate a solar evaporator to file a notice of intent with the regional water quality control board. The bill would specify a procedure for the issuance of a notice of authority by the regional board to operate a solar evaporator, including requiring the regional board to inspect the solar evaporator prior to authorizing the operation of the solar evaporator. The bill would prohibit a regional board from issuing a notice of authority to operate a solar evaporator on and after January 1, 2008.

The bill would require any person operating a solar evaporator to submit annually, according to a schedule established by the regional board, groundwater monitoring data and other information deemed necessary by the regional board. The bill would require the regional board to inspect any solar evaporator at least once every 5 years to ensure continued compliance with the provisions of the bill.

The bill would exempt any solar evaporator operating under a valid written notice of authority to operate issued by the regional board, including any facility that the regional board determines is in compliance with the requirements of the bill, from the provisions of the toxic pits act and other specified waste discharge requirements imposed under the Porter-Cologne Water Quality Control Act.

Because the provisions added by the bill would be located within the hazardous waste control laws and a violation of those laws is a crime, the bill would impose a state-mandated local program by creating new crimes regarding the operation of solar evaporators.

(2) Existing law, the toxic pits act, requires the state board to impose a fee upon any person discharging any liquid hazardous waste or hazardous waste containing free liquids into a surface impoundment. The state board is required to collect and deposit the fees in the Surface Impoundment Assessment Account in the General Fund. The money within that account is available, upon appropriation, to the state board and the regional boards for purposes of administering the toxic pits act.

This bill would additionally authorize the board to expend the fees deposited in the account for the purpose of administering the surface impoundments that would be exempted from the toxic pits act by the bill, thereby imposing a tax for purposes of Article XIII A of the California Constitution.

(3) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement.

This bill would provide that no reimbursement is required by this act for a specified reason.

The people of the State of California do enact as follows:

SECTION 1. Section 25208.3 of the Health and Safety Code is amended to read:

25208.3. (a) The state board shall, by emergency regulation, adopt a fee schedule that assesses a fee upon any person discharging any liquid hazardous wastes or hazardous wastes containing free liquids into a surface impoundment, except as provided in Section 25208.17. The state board shall include in this fee schedule the fees charged for applications for, and renewals of, an exemption from Section 25208.5, as specified in subdivision (h) of Section 25208.5, from subdivision (a) of Section 25208.4, as specified in subdivision (b) of Section 25208.4, from subdivision (c) of Section 25208.4, as specified in Section 25208.16, and from Sections 25208.4 and 25208.5, as specified in subdivision (e) of Section 25208.13. The state board shall also include provisions in the fee schedule for assessing a penalty pursuant to subdivision (c). The state board shall set these fees at an amount equal to the state board's and regional board's reasonable and anticipated costs of administering this article.

(b) The emergency regulations that set the fee schedule shall be adopted by the state board in accordance with Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, and for the purposes of that chapter, including Section 11349.6 of the Government Code, the adoption of these regulations is an emergency and shall be considered by the Office of Administrative Law as necessary for the immediate preservation of the public peace, health and safety, and general welfare. Notwithstanding Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, any emergency regulations adopted by the state board pursuant to this section shall be filed with, but not be repealed by, the Office of Administrative Law and shall remain in effect until revised by the state board.

(c) The state board shall send a notice to each person subject to the fee specified in subdivision (a). If a person fails to pay the fee within 60 days after receipt of this notice, the state board shall require the person to pay an additional penalty fee. The state board shall set the penalty fee at not more than 100 percent of the assessed fee, but in an amount sufficient to deter future noncompliance, as based upon that person's past history of compliance and ability to pay, and upon additional expenses incurred by this noncompliance.

(d) The state board shall collect and deposit the fees collected pursuant to this article in the Surface Impoundment Assessment Account, which is hereby created in the General Fund. The money within the Surface Impoundment Assessment Account is available, upon appropriation by the Legislature, to the state board and the regional boards for purposes of administering this article and Article 9.7 (commencing with Section 25209.10).

SEC. 2. Article 9.7 (commencing with Section 25209.10) is added to Chapter 6.5 of Division 20 of the Health and Safety Code, to read:

Article 9.7. Integrated On-Farm Drainage Management

25209.10. The Legislature finds and declares all of the following:

(a) The long-term economic and environmental sustainability of agriculture is critical to the future of the state, and it is in the interest of the state to enact policies that enhance that sustainability.

(b) High levels of salt and selenium are present in many soils in the state as a result of both natural occurrences and irrigation practices that concentrate their presence in soils.

(c) The buildup of salt and selenium in agricultural soil is an unsustainable practice that degrades soil, harms an irreplaceable natural resource, reduces crop yields and farm income, and poses threats to wildlife.

(d) Salt and selenium buildup can degrade groundwater, especially in areas with perched groundwater aquifers.

(e) Off-farm drainage of irrigation water with high levels of salt and selenium degrades rivers and waterways, particularly the San Joaquin River and its tributaries. This environmental damage presents a clear and imminent danger that warrants immediate action to prevent or mitigate harm to public health and the environment.

(f) Discharge of agricultural drainage water to manmade drains and ponds has resulted in environmental damage, including damage to wildlife. Proposals to discharge agricultural drainage to natural water bodies, including the San Francisco Bay, are extremely expensive and pose threats to the environmental quality of those water bodies.

(g) Water supplies for agricultural irrigation have been reduced significantly in recent years, necessitating increased efforts to use water more efficiently.

(h) Although salt can be collected and managed as a commercial farm commodity, California currently imports salt from other countries.

(i) Integrated on-farm drainage management is a sustainable system of managing salt-laden farm drainage water. Integrated on-farm drainage management is designed to eliminate the need for off-farm drainage of irrigation water, prevent the on-farm movement of irrigation and drainage water to groundwater, restore and enhance the productive value of degraded farmland by removing salt and selenium from the soil, conserve water by reducing the demand for irrigation water, and create the potential to convert salt from a waste product and pollutant to a commercial farm commodity.

(j) Although integrated on-farm drainage management facilities are designed and operated expressly to prevent threats to groundwater and wildlife, these facilities currently may be classified as surface impoundments pursuant to the Toxic Pits Act of 1984, which discourages farmers from using them as an environmentally preferable means of managing agricultural drainage water.

(k) It is the policy of the state to conserve water and to minimize the environmental impacts of agricultural drainage. It is therefore in the interest of the state to encourage the voluntary implementation of sustainable farming and irrigation practices, including, but not limited to, integrated on-farm drainage management, as a means of improving environmental protection, conserving water, restoring degraded soils, and enhancing the economic productivity of farms.

25209.11. For purposes of this article, the following terms have the following meanings:

(a) ‘‘Agricultural drainage water’’ means surface drainage water or percolated irrigation water that is collected by subsurface drainage tiles placed beneath an agricultural field.

(b) ‘‘On-farm’’ means within the boundaries of a property, geographically contiguous properties, or a portion of the property or properties, owned or under the control of a single owner or operator, that is used for the commercial production of agricultural commodities and that contains an integrated on-farm drainage management system and a solar evaporator.

(c) ‘‘Integrated on-farm drainage management system’’ means a facility for the on-farm management of agricultural drainage water that does all of the following:

(1) Reduces levels of salt and selenium in soil by the application of irrigation water to agricultural fields.

(2) Collects agricultural drainage water from irrigated fields and sequentially reuses that water to irrigate successive crops until the volume of residual agricultural drainage water is substantially decreased and its salt content significantly increased.

(3) Discharges the residual agricultural drainage water to an on-farm solar evaporator for evaporation and appropriate salt management.

(4) Eliminates discharge of agricultural drainage water outside the boundaries of the property or properties that produces the agricultural drainage water and that is served by the integrated on-farm drainage management system and the solar evaporator.

(d) ‘‘Regional board’’ means a California regional water quality control board.

(e) ‘‘Solar evaporator’’ means an on-farm area of land and its associated equipment that meets all of the following conditions:

(1) It is designed and operated to manage agricultural drainage water discharged from the integrated on-farm drainage management system.

(2) The area of the land that makes up the solar evaporator is equal to, or less than, 2 percent of the area of the land that is managed by the integrated on-farm drainage management system.

(3) Agricultural drainage water from the integrated on-farm drainage management system is discharged to the solar evaporator by timed sprinklers or other equipment that allows the discharge rate to be set and adjusted as necessary to avoid standing water within the solar evaporator or, if a water catchment basin is part of the solar evaporator, within that portion of the solar evaporator that is outside the basin.

(4) The combination of the rate of discharge of agricultural drainage water to the solar evaporator and subsurface tile drainage under the solar

evaporator provides adequate assurance that constituents in the agricultural drainage water will not migrate from the solar evaporator into the vadose zone or waters of the state in concentrations that pollute or threaten to pollute the waters of the state.

(f) "State board" means the State Water Resources Control Board.

(g) "Water catchment basin" means an area within the boundaries of a solar evaporator that is designated to receive and hold any water that might otherwise be standing water within the solar evaporator. The entire area of a water catchment basin shall be permanently and continuously covered with netting, or otherwise designed, constructed, and operated to prevent access by avian wildlife to standing water within the basin.

25209.12. On or before April 1, 2003, the state board, in consultation, as necessary, with other appropriate state agencies, shall adopt emergency regulations that establish minimum requirements for the design, construction, operation, and closure of solar evaporators. The regulations shall include, but are not limited to, requirements to ensure all of the following:

(a) The operation of a solar evaporator does not result in any discharge of on-farm agricultural drainage water outside the boundaries of the area of land that makes up the solar evaporator.

(b) (1) The solar evaporator is designed, constructed, and operated so that, under reasonably forseeable operating conditions, the discharge of agricultural water to the solar evaporator does not result in standing water.

(2) Notwithstanding paragraph (1), a solar evaporator may be designed, constructed, and operated to accommodate standing water, if it includes a water catchment basin.

(3) The board may specify those conditions under which a solar evaporator is required to include a water catchment basin to prevent standing water that would otherwise occur within the solar evaporator.

(c) Avian wildlife is adequately protected. In adopting regulations pursuant to this subdivision, the state board shall do the following:

(1) Consider and, to the extent feasible, incorporate best management practices recommended or adopted by the United States Fish and Wildlife Service.

(2) Establish guidelines for the authorized inspection of a solar evaporator by the regional board pursuant to Section 25209.15. The guidelines shall include technical advice developed in consultation with the Department of Fish and Game and the United States Fish and Wildlife Service that may be used by regional board personnel to identify observed conditions relating to the operation of a solar evaporator that indicate an unreasonable threat to avian wildlife.

(d) Constituents in agricultural drainage water discharged to the solar evaporator will not migrate from the solar evaporator into the vadose zone or the waters of the state in concentrations that pollute or threaten to pollute the waters of the state.

(e) Adequate groundwater monitoring and recordkeeping is performed to ensure compliance with the requirements of this article.

(f) Salt isolated in a solar evaporator shall be managed in accordance with all applicable laws and shall eventually be harvested and sold for commercial purposes, used for beneficial purposes, or stored or disposed in a facility authorized to accept that waste pursuant to this chapter or Division 30 (commencing with Section 40000) of the Public Resources Code.

25209.13. (a) Any person who intends to operate a solar evaporator shall, before installing the solar evaporator, file a notice of intent with the regional board, using a form prepared by the regional board. The form shall require the person to provide information including, but not limited to, all of the following:

(1) The location of the solar evaporator.

(2) The design of the solar evaporator and the equipment that will be used to operate it.

(3) The maximum anticipated rate at which agricultural drainage water will be discharged to the solar evaporator.

(4) Plans for operating the solar evaporator in compliance with the requirements of this article.

(5) Groundwater monitoring data that are adequate to establish baseline data for use in comparing subsequent data submitted by the operator pursuant to this article.

(6) Weather data and a water balance analysis sufficient to assess the likelihood of standing water occurring within the solar evaporator.

(b) The regional board shall, within 30 calendar days after receiving the notice submitted pursuant to subdivision (a), review its contents, inspect, if necessary, the site where the proposed solar evaporator will be located, and notify the operator of the proposed solar evaporator whether it will comply with the requirements of this article. If the regional board determines that the proposed solar evaporator will not comply with this article, the regional board shall issue a written response to the applicant identifying the reasons for noncompliance. If the regional board determines the solar evaporator will comply with the requirements of this article, the regional board shall issue a written notice of plan compliance to the operator of the proposed solar evaporator.

(c) Any person who receives a written notice of plan compliance pursuant to subdivision (b) shall, before operating the installed solar evaporator, request the regional board to conduct a compliance inspection of the solar evaporator. Within 30 calendar days after receiving a request, the regional board shall inspect the solar evaporator and notify the operator whether it complies with the requirements of this article. If the regional board finds that the solar evaporator does not comply with the requirements of this article, the regional board shall issue a written response to the applicant identifying the reasons for noncompliance. Except as provided in subdivision (e), if the regional board determines that the solar evaporator complies with the requirements of this article, the regional board shall issue a written notice of authority to operate to the operator of the solar evaporator. The regional board may include in the authority to operate any associated condition that the regional board deems necessary to ensure compliance with the purposes and requirements of this article.

(d) No person may commence the operation of a solar evaporator unless the person receives a written notice of authority to operate the solar evaporator pursuant to this section.

(e) (1) On and after January 1, 2008, a regional board may not issue a written notice of authority to operate a solar evaporator pursuant to this section.

(2) The requirements of paragraph (1) do not affect the validity of any written notice of authority to operate a solar evaporator issued by the regional board before January 1, 2008.

(f) The regional board shall review any authority to operate issued by the regional board pursuant to this section every five years. The regional board shall renew the authority to operate, unless the regional board finds that the operator of the solar evaporator has not demonstrated compliance with the requirements of this article.

25209.14. (a) Any person operating a solar evaporator shall annually, according to a schedule established by the regional board pursuant to subdivision (b), submit groundwater monitoring data and any other information that is deemed necessary by the regional board to ensure compliance with the requirements of this article.

(b) Each regional board shall adopt a schedule for the submission of the data and information described in subdivision (a) at the earliest possible time. The regional board shall notify the operator of each solar evaporator of the applicable submission schedule.

25209.15. (a) The regional board, consistent with its existing statutory authority, shall inspect any solar evaporator that is authorized to operate pursuant to Section 25209.13 at least once every five years to ensure continued compliance with the requirements of this article. In conducting any inspection, the regional board may request the participation of a qualified state or federal avian biologist in a technical advisory capacity. The regional board shall include in the inspection report conducted pursuant to this section any evidence of adverse impacts on avian wildlife and shall forward the report to the appropriate state and federal agencies.

(b) If the regional board, as a result of an inspection or review conducted pursuant to this article, determines that a solar evaporator is not in compliance with the requirements of this article, the regional board shall provide written notice to the operator of the solar evaporator of that failure, and shall include in that written notice the reasons for that determination.

(c) Chapter 5 (commencing with Section 13300) of, and Chapter 5.8 (commencing with Section 13399) of, Division 7 of the Water Code apply to any failure to comply with the requirements of this article and to any action, or failure to act, by the state board or a regional board. The regional board may, consistent with Section 13223 of the Water Code, revoke or modify an authorization to operate issued pursuant to this article.

25209.16. (a) For the purposes of Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, including Section 11349.6 of the Government Code, the adoption of the regulations required to be adopted pursuant to Section 25209.12 is an emergency and shall be considered by the Office of Administrative Law as necessary for the immediate preservation of the public peace, health and safety, and general welfare.

(b) Notwithstanding Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, any emergency regulations adopted by the state board pursuant to Section 25209.12 shall be filed with, but not be repealed by, the Office of Administrative Law and shall remain in effect until revised by the state board.

25209.17. Any solar evaporator operating under a valid written notice of authority to operate issued by the regional board pursuant to this article, including any facility operating pursuant to Article 9.5 (commencing with Section 25208) prior to January 1, 2003, that the regional board determines is in compliance with the requirements of this article, is not subject to Article 9.5 (commencing with Section 25208) or Sections 13260 or 13263 of the Water Code. Upon determining pursuant to this section that a facility is a solar evaporator in compliance with this article, the regional board shall, as appropriate, revise or rescind any waste discharge requirements or other requirements imposed on the operator of the facility pursuant to Article 9.5 (commencing with Section 25208) or Section 13260 or 13263 of the Water Code.

SEC. 3. No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because the only costs that may be incurred by a local agency or school district will be incurred because this act creates a new crime or infraction, eliminates a crime or infraction, or changes the penalty for a crime or infraction, within the meaning of Section 17556 of the Government Code, or changes the definition of a crime within the meaning of Section 6 of Article XIII B of the California Constitution.